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THE EDINBURGH PHILOSOPHICAL JOURNAL.

Art. I.—*On the Ice-caves or Natural Ice-houses found in some of the Caverns of the Jura and the Alps* *. By M. A. Pictet, F. R. S. L. & E. &c., and Professor of Natural Philosophy at Geneva.

THE extraordinary mildness of last winter, which could not furnish the ordinary provision for the artificial ice-houses, and the early and remarkable heat of the summer which has succeeded it, have turned the attention of the public towards those natural ice-caves which exist in different places, and which furnish an inexhaustible quantity of ice, in all seasons, to those who are sufficiently near these repositories to be able to profit by them.

Independently of their utility in this point of view, these singular masses of ice, existing in places where the mean temperature is far above the freezing point, present, in their origin and their preservation, questions worthy of the attention of philosophers, particularly as they are connected with similar phenomena observed in situations otherwise very different.

There are, in the chain of the Jura, at least two of these natural ice-caves; one called La Baume, is situated five leagues from Besançon, near the Abbey of Grace Dieu; the other lies in the slope of the Jura, which bounds the Canton de Vaud, about 5000 toises, as the bird flies, to the N.W. of Rolle.

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* Read at the Helvetic Society of the Natural Sciences, which met at Berne in July 1822. Professor Pictet had the goodness to transmit to us this curious paper for insertion in this Journal, before it was published in the *Bibliotheque Universelle*.

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Two other caverns which likewise contain ice all summer, are found in the mountains of Faucigny; the one upon that called Brezon, at some distance to the south of Bonneville; the other in the south-west declivity of Mount Vergy, in the valley of Reposoir, not far from Cluse. I have recently visited the three last: Before speaking of them, I shall describe briefly that of La Baume, which I have not seen, but of which I have found very detailed descriptions; one in a letter addressed by M. De Cossigny to M. De Reaumur, in 1743, and inserted in the first volume of the *Memoires des Sçavans Etrangers*, (p. 195.), with an engraving, containing a plan and section of the grotto; and the other in a letter from Professor Prevost, addressed to the editor of the Geneva Journal, and published in the number for March 21. 1789. From these two sources, I have principally taken the details which follow.

M. De Cossigny visited this cavern twice, in the month of August 1743, and in October 1745. He took the plan of it, and made several interesting observations upon the physical phenomena which its interior presented. The following is an abridgment of them.

The cavity is 64 toises in length, by 22 at the widest part; the bottom inclines downwards very rapidly from the entrance, as there is a descent of 30 toises in its length; the height of the vault, which is of an elliptical form, varies from 10 to 15 toises.

M. De Cossigny, in his first journey, found that the thermometer stood a degree of Fahr. above the freezing point, in the interior; whilst at the entrance without, it was at 77° Fahr. in the month of August. In the month of October 1745, the thermometer was at 32° in the interior, and 50° at the entrance. In both visits, he found that the bottom of the cavern presented a surface of ice, with a little water in the cavities.

Towards the extremity, the ice assumed the form of conical stalactites, in consequence of the drops of water which fell from the roof freezing successively.

In the Memoirs of the Royal Academy of Sciences for 1712, we find the account of a visit to this cavern in September 1711, by M. Billerez, of Besançon. "I found," says he, "that the inner end of the cavern, which is flat, was covered with ice 3 feet in thickness, which was beginning to melt." He also saw three py-

ramids of ice, 15 or 20 feet in height, by 5 or 6 wide. "There began (says he) to appear at the top of the entrance, a mist which comes out of it all winter, and which announces or accompanies the thaw of the ice."—"The hotter (he continues) the summer is, the greater is the quantity of ice."

In 1727, at the time of the camp of the Saone, the Duke de Levi sent a great number of waggons daily, and carried off all the ice both of the pyramids and from the bottom of the grotto, which was entirely uncovered. This fact, compared with the abundance of ice found there in 1743, by M. De Cossigny, proves that the cause of congelation exists, notwithstanding the removal of the ice, and that the ice is very quickly formed.

The following is the appearance which the grotto presented to Professor Prevost, in August 1769.

"The interior of the grotto," says he, "appeared to be divided into three compartments, distinguished from each other by the shape of the rocks, and by the difference of the phenomena. On entering this place, in a very hot day, in the middle of August, I felt a chilling cold; and the first object which struck my eye, was a mass of ice, fed by the water which distilled constantly, drop by drop, from a sort of source in the roof. The cavern is entirely covered, from the entrance, to where the bottom begins to rise, with a pavement of solid ice, in which are several holes, where the water appears cold, and almost at the freezing point. In sounding one of these wells, the depth of the ice upon the bottom appeared to be about a foot. According to the report of my guide, it appeared that, in winter, the ice formed great icicles, or stalactites, which hung from the roof, and melted or fell in spring. This circumstance, and some others, change the number and disposition of the masses and pyramids which rise from the icy pavement of the cavern."

"The evaporation is considerable. It often produces a thick fog in the interior of the grotto. M. De Cossigny found this fog more visible in August than in October; but there was none when I visited it."

To these observations, we shall add the important remark, that this grotto is hollowed out naturally in a low hill, and consequently that its entrance is in the atmospheric region the mean temperature of which is far above the freezing point. It must

also be observed, that, from the form of this cavity, the winter snow cannot enter, and therefore cannot, in any visible manner, contribute to the formation of the ice in the interior, especially if we consider that it is more particularly at the remotest extremity of the grotto that the ice is formed and accumulated.

To conclude this local description, it may be mentioned, that the outer surface above the grotto, continues to rise from the entrance, to the distance of 20 toises, and afterwards continues nearly horizontal, and covered with wood. By measuring the section of the cavern given lengthwise by M. De Cossigny, the thickness of the earth above the vault, at the part of the grotto which is lowest, that is, at its extremity, will be found to be about 150 feet.

I now proceed to the second cavern of the Jura, which I have already mentioned, that of St George's. To reach the village of that name, we must take the road from Rolle as far as Gimel, which is the high road of the valley of the Lake de Joux, and which I here quitted for the road to St George's, where I arrived at 8 o'clock in the morning of the 7th of July, having left Rolle at 6 o'clock. The barometer gave 281.4 toises for the height of St George's above the lake of Geneva.

The village is situated precisely at the foot of the last ascent of the first line of the Jura; and it is in this slope that the ice-cave is situated. We quitted the car in which we had come, and began to climb on foot, conducted by the best possible guide, as we had the peasant who had hired the ice-cave from the commune of St George's, to whom it belongs. His lease has lasted for twenty-five years, on very moderate terms. He informed us, as we went along, of the following particulars.

In ordinary years, it only furnishes ice to a small number of families, who pass the summer at Rolle, and in a circle of about two leagues round the grotto: but, in such years as the last, when the winter did not furnish a sufficient quantity of ice, to fill the artificial ice-houses, Geneva, although eight or nine leagues distant, had recourse to this substitute. This circumstance occurred this year for the third time. It took place, also, in 1818 and in 1820.

He carries to Geneva every second day during the summer, about twenty-five quintals of ice, which he sells to the hospital,

which has the privilege of retailing it, part of its revenue being derived from this monopoly.

After climbing for three quarters of an hour by paths, which are practicable for horses accustomed to the mountain, we reached an esplanade, called Le Grand Pré, where we found a cottage, from which the view is magnificent. Under the eye lay the lake of Geneva in its full extent, presenting its true geographical form; and behind it, the chain of the Alps, crowned by Mont Blanc, terminated the picture. We found by the barometer, that we had ascended 143 toises from the village, or 424 from the lake.

We continued to ascend for some minutes longer, and soon reached the most elevated point of the path; from thence we descended a little, in order to arrive at the ice-cave, the entrance of which we found, by the barometer, to be 427 toises above the lake. It is situated in a wood of pines, thinly scattered, and the surface of which is unequal. We discovered on arriving, two natural pits, nearly circular, hollowed in the rock, beside each other, of about twelve feet diameter, and separated by a space of about as many feet.

It is by those pits, which lie to the right in looking towards the mountain, that you descend into the ice-cave by means of two ladders; the first is almost vertical, the second is more inclined, and they are composed of forty-six steps. From thence you enter the grotto, by a short inclined plane, which terminates in the mass of ice, horizontal, or nearly so, on which the workmen were employed, and which forms the bottom or floor of the ice-cave.

In order to give an idea of the form of this cavern, we shall suppose, that, stopping at the entrance, we look at it in the direction of its length, a direction nearly perpendicular to that of the chain of the Jura. The half of the vault, to the left, will then present the appearance of the quarter of a tolerably regular ellipsoid, which will be seen in the direction of its greater axis, and abruptly cut throughout all its length, as if the half to the right, that which answers to the vertical of the spectator, was separated from it, and was lost in the bottom of the grotto, to an unknown depth, because it is full of ice. The height of the highest point of this half hemisphere, above the actual sur-

face of the ice, is about 27 feet; and the thickness of the bed of compact calcareous rock, which forms this enormous vault, is about 18 inches in thickness only.

The length of the icy surface, that is, almost the whole length of the grotto, is 75 feet, and the mean width 40 feet, which gives for the total of the workable surface $75 \times 40 = 3000$ square feet, and as many cubic feet for each layer of ice of a foot thick, which is carried away. A French cubic foot of pure ice weighs about 65 lb. marc weight, which gives, for the supposed depth of a foot, carried away from the whole extent of the grotto, $3000 \times 65 = 195{,}000$ lb., making 1950 quintals of ice, which would load 68 waggons, carrying 25 quintals each.

The working of the ice is the same as that of a quarry: it is cut with appropriate tools into long wedges, and divided by transverse cuts about a foot distant from each other, and sufficiently deep to enable them easily to detach blocks of a cubic foot. They work for two or three hours in preparing a certain quantity of them, which they then carry one by one in hods, to a magazine near the place where the waggons are loaded.

The part of the grotto to the left, and which is more particularly under the ellipsoidal vault, already mentioned, rises against the lower part of this vault, with a very rapid slope. The part to the right, the roof of which is very irregular, is occupied by the workable ice; and the natural wall which bounds it to the right, is almost vertical.

There are at the extremity of the grotto, at a certain height against its partitions, stalactites, which one would take at the first view for carbonate of lime, but which are ice of an opaque white. They are formed against the inclined partitions of the grotto, by the filtering of a small current of water, which is visible towards the extremity of the grotto to the right, between the ice and the almost vertical partition of rock which encloses it; and there it falls into a very deep hole. It is to be presumed that all this depth is filled up by the mass of ice which was under our feet.

The thermometer which, suspended in the open air and in the shade, at the outside of the grotto, stood at 63° of Fahr., when placed in the middle of the grotto, 2 feet above the

surface of the ice, stood at 34°½ during the whole time we remained there.

The work-people told us, that if they left two blocks of ice close to each other on the bottom of the grotto, they found them frozen together next day; which proves that the process of congelation goes on continually in the interior of the grotto, even in the hot seasons.

On our return, our guide made us pass by a spring, which issues from the middle of an enormous mass of vertical rock. It lies a gunshot to the east in descending. The temperature was 51°. This temperature is nearly that of the mass of rock from which it issues, that is, of the soil of the mountain at this height. This fact renders the cold which pervades the neighbouring cavern only the more extraordinary.

It still remained for me to visit the other two natural ice-caves, which I have before mentioned, that of Mont *Brezon* and that of *Reposoir*, which I accomplished on the 16th and 17th of July.

The ascent of *Brezon* begins at the little village of Thuet, situated immediately at the foot of the mountain: almost all its inhabitants are afflicted with goitres, more or less projecting. We set out at ten o'clock from Bonneville, and at ten minutes after eleven, we arrived at the granary called La Croix, a cultivated slope, which is seen from Bonneville. We found by the barometer that we had ascended 148.4 toises. A little farther on, the path became very picturesque, creeping round the foot of enormous masses of calcareous rock, which were on the right, and overhanging a torrent, which comes out of the little lake of Saxonnet, and rushed through a profound ravine on the left. The geologist observes in front, in the twisted strata of the other side of the ravine, one of the most striking phenomena to be met with. We saw there an enormous vertical mass, surmounted by another, horizontal, and nearly of the same extent. The first is bent towards the middle of its vertical mass, by a curve, which seems to have been the effect of a local pressure, operating whilst the whole mass was in a soft state, but which had been preserved, notwithstanding its stratification, in parallel beds of nearly equal thickness. Soon after, the path is boldly traced in the front of two grottoes, the one situated above the other.

From thence there is scarcely any ascent to the village of Brezon, where we arrived at half-past twelve o'clock. The guide to whom we trusted was absent; but chance procured us another. We set out immediately with our guide, for the Ice Cave, which was much more distant than one hour's walk. We found by the barometer, that our guide's house, from whence we departed, was 314 toises above the lake. The weather being bad, and having caught a severe cold, I resolved to leave the prosecution of it to my grandson, Edward Prevost, who ascended to the Ice Cave with the guide. I shall give the following account of it in the words of my grandson.

"The guide and I ascended till we arrived at the base of that immense inclined face of rock, which descends from the chain of Mount Vergy, and whose barren and desolated aspect makes it visible from a great distance, especially at sunset. This platform terminates in an abrupt manner, descending to the north towards the region of wood. We followed for some time this natural wall, from left to right, and, after a slight turn to the left, we reached a place, where a strong current of very cold air issued from an opening in the rock, about two feet from the ground. The thermometer, which in the open air stood at 51°, when exposed to this current fell immediately to 38°$\frac{3}{4}$. About ten toises farther, at the foot of the same natural wall, surmounted by the desert already mentioned, we found the Ice Cave. The entrance is small, and partly obstructed by calcareous blocks, which appear to have fallen from the roof. A little farther in, we found ourselves in a cavity of a very irregular form, into which the daylight, and also the winter's snow, penetrates by an opening in the form of a funnel, and which the snow still partly obstructed.

"The extremity opposite to the entrance is so low, that the guide was obliged to stoop very much, in placing the end of the ribbon, which we made use of to measure with. The greatest length of the grotto was only thirty feet; its breadth, which is very irregular, was about twenty-five, and its height ten or twelve at most.

"The temperature of the interior was 41°. The barometer at the entrance was 24. 1,8, which gives 148.1 toises for the

height above the village of Brezon, that is 462 toises above the lake.

"The discharge of cold air was not confined to the orifice mentioned above. There issued a stream more or less cold and rapid, from all the natural and irregular openings in the vertical rock, of which I have been speaking. The direction of the canal, by which it issued, was downwards, and plunged into the mass of rock at an angle of 15° or 20°.

"It is impossible to estimate either the thickness of the ice contained in this cavern, or its surface, which is very irregular. A part of it was evidently a remnant of the winter's snow; the remainder derived its origin from the local congelation of the water operating as in the cavern of St George's. The guide asserted that the process of congelation took place in summer also."

After descending to the plain, we passed the night at Bonneville. The next morning, at three quarters past five o'clock, we set out for Scionzier, a village situated at the entrance of the valley of Reposoir, by which we were to ascend to the Ice Cave of the Vergy Mountains. We arrived at the village at a quarter past seven o'clock. Weakened by the illness of the evening before, I took a horse for part of the ascent from the village.

Our guide had, in 1807, accompanied two of our countrymen (MM. Necker and Colladon), in the same excursion we intended to make; and he believed, that since that period, no one had, from curiosity, visited the cavern, which is much less known than it deserves to be. We skirted along the side of a narrow and wooded valley, in the bottom of which rolled the foaming torrent called Foron. In this region, entirely calcareous, we frequently met with enormous rounded blocks of granite, deposited on the steep side of the valley, at the epoch of the grand convulsion, which brought them from the central chain of the Alps. It is difficult to conceive how these blocks could reach this height, in a narrow and steep pass, shut up at the highest extremity by a circle of very lofty peaks.

In skirting along the southern face of the Vergy Mountains, which we did during the whole route, we remarked that the calcareous beds which compose them, are, on this side, almost vertical, resting against the chain, in the same manner as we see them in looking from the north side, on the road from Bonne-

ville to Cluse. One may form an idea of this appearance, by placing a pack of cards on end, in such a manner that they open at the bottom, in a very acute angle, just sufficient to enable them, when supported against each other at the top, to maintain this situation.

After having travelled an hour and a quarter, we arrived at a place where the valley, now become very narrow, is shut up by a building, the door of which is the sole entrance by which one can penetrate higher into the domains which belonged formerly to the Chartreuse of the Reposoir. We found by the barometer that we had ascended 223.4 toises from Scionzier.

After resting for a short time, we proceeded, and arrived at a quarter past ten, at the level of the Chartreuse, which we passed, leaving it a little to the left. We saw from hence the high peaks, called Les Tours, which are above Sallanches, and whose highest summit is called *Pierre Percée*, from a hole which is visible in it.

An inhabitant of the district informed us, that they are accessible, although they have very little appearance of it. He had ascended last year, and was the fourteenth to reach the highest point; his wife arrived the first, and they have made a party to return this year, and plant a cross upon the summit. The barometer observed at the height of the buildings of the Reposoir, determined the height of this Chartreuse to be 322.3 toises above the lake. We arrived at mid-day at a hut called Le Selle. We found by the barometer that we had climbed 113.3 toises from Reposoir; we had some difficulty in penetrating into the hut, besieged as it was by the cows, who had come to be milked: but having once made good our entrance, we met with a most hospitable reception, and milk in every possible form was presented for our choice. We left our poney here, in a very numerous society of quadrupeds. From hence it occupied us an hour and a quarter to reach the hut of Montarkt, where the cows were to arrive next day, to establish themselves for the rest of the season. From this hut we at last arrived at the Glacier, after a very steep climb for 40 minutes.

It is situated, not in the southern face of the chain of the Vergy, but in the most western of the passes which separate the different summits of the chain, and at a short distance from the

culminating point of the pass. In order to reach the grotto, we ascended along the foot of the rocks, in a direction perpendicular to that of the chain, and as if we proposed to cross it, by the pass up which we clambered, having on our right the rocks which form part of the central mass of the mountain. We found, in scrambling along the foot of the rock, a tolerably spacious cavern, in which tradition says, a band of coiners were formerly discovered. This grotto is cold, but without ice. A few toises higher we arrived at the ice-cave, situated in the same mass of rocks, but which is announced majestically by a low vault, 43 feet in width at the base. We were immediately sensible of an extreme degree of cold which issued from it, and against which it is the more necessary to take precautions, that it is almost impossible to reach it without being overheated.

From the entrance the cavity becomes much wider. We descended by a gently inclined plane, at the bottom of which is a horizontal platform of ice, of 60 feet in length, by 30 in width; it is not thick where it commences, but becomes more so as it advances towards the extremity. The ice rises in a slope against the rock, which terminates the grotto. On the left side of the ice a stalagmite of the same material rises to about the height of two feet, formed by the water which drops from a crevice in the vault, which is not very high.

If, after arriving at the extremity of this fine cavern, we turn round to look at the interior, it will present a coup-d'œil which we recommend to draughtsmen as extremely picturesque.

The temperature at a foot above the ice was $34^{\circ}\frac{3}{4}$. In the open air, and beyond the refrigerating influence, it was 58°. The barometer, constructed in London, and intended for the English mountains, which are not so high as ours, was of no use in determining the height of the cavern above the lake; the mercury could not descend lower, the reservoir being full.

Our guide informed us, that when he visited the cavern in April last, he found no ice, but a considerable depth of water towards its extremity. He praised its beauty at present, which he declared to be greater than he had ever witnessed. It may be well to remark, that the present year is very extraordinary,

from the height of its mean temperature, which accords with the opinion of the inhabitants of the neighbourhood, that the hotter the season is, the greater is the cold, and the quantity of ice that is formed. However that may be, we had no reason to repent the trouble we had taken in this last expedition, as the grotto is in every respect much superior to the other two. We remained there till three o'clock in the afternoon, and returned to Geneva at eleven o'clock at night.

After having stated the principal phenomena, and the various circumstances which fell under our immediate observations in three different ice-caves, we shall now proceed to hazard some conjectures respecting their cause.

We may remark, in the *first* place, That in two of the three ice-caves we visited (indeed we may say of the four, including that of La Baume), we cannot consider the winter's snow as a possible or probable cause, although it might be a concomitant cause in the ice-cave of Brezon. Neither can we admit that the natural temperature of the earth favours these formations, for, in our latitudes, the mean temperature is far above the freezing point. Even our deepest springs indicate that it seldom falls below eight degrees. Besides, if this effect was produced by the temperature of the earth, there would be ice found wherever there were natural caverns; whereas, on the contrary, there exists a vast cavern without any ice very near the last ice-cave which we visited.

It must be acknowledged, then, that we ought to have recourse to some particular local cause, in order to account for the formation of ice in some caverns and not in others. One of the observations made at the ice-cave of Brezon, puts us in the way of being able to solve this interesting problem: I mean that of the current of cold air, which issued with force from several openings in the rock near the cavern. Let us connect this fact with a class of phenomena, which have so much resemblance to those which have just occupied us, that the consideration of them may throw some light upon the causes which form and support the natural ice-caves. I mean those subterraneous cavities from whence issue in summer currents of air, not only colder than the external air, but than the mean temperature of the soil in the regions where they are observed.

Our celebrated countryman Saussure bestowed a great deal of attention on this phenomenon. The observations and reflections which he made on the subject, are to be found in the 3d volume of his Travels among the Alps, (p. 1404—1415). I shall now proceed to give a short account of them.

There is near Rome a little hill of 200 or 300 feet high, almost entirely composed of broken pieces of urns, and other vases of earthen ware, and for this reason called Monte Testaceo. Several caves have been dug round its base, in the back-walls of which chimneys have been opened, and from whence there blows into the caves a cold wind which cools them. On July 1, 1773, the external air being in the shade at 78°.1 Fah., the thermometer remained at $44^\circ\frac{3}{4}$ in one of these caves, and at 44° in another, according to the observations of Saussure. "It is certainly a very singular phenomenon (says he), that in the middle of the Campagna of Rome, where the air is always burning hot and suffocating, there should be found a little insulated hill, from the base of which should issue, on all sides, currents of air of an extreme coolness."

It is not less singular, he adds, that in a climate still farther to the south, and in an island such as Ischia, near Naples, which is entirely volcanic, and abounds in hot springs, a cold wind, such as we have just described, should occur. Saussure found, by the observation he made March 9. 1773, that the thermometer was $63^\circ\frac{1}{2}$ in the open air, and $45^\circ\frac{1}{2}$ at the extremity of the grotto. He was told, at the same time, that in the great heats of summer he would have found it much lower.

At the foot of the freestone hill, upon which is situated the town of St Marin, at the height of 325 toises above the sea, there are likewise cold caves, where, on the 9th of July 1773, Saussure found the thermometer at $45^\circ\frac{1}{2}$; when in the open air it was at $61^\circ\frac{1}{4}$.

In a private house, in the little town of Cosi near Terni, in the Papal States, there is a cellar, not very deep, in which a cold wind issues with considerable impetuosity from the crevices of the rocks, against which it is placed. In July 4. 1773, Saussure found that the temperature of this current was 45°, while the outward air was 64°6.

The cold caves called *Cantines*, at Chiavenna, in Italian Switzerland, rest against a rock from whence issues a cold wind, which Saussure ascertained, August 5. 1777, at noon, to be at 45° Fahr., while the external air was at 70°.

Those which he had observed with the greatest attention, says he, and where he found the air the coldest, were those of Caprino on the edge of the lake of Lugano, at the foot of a calcareous mountain, the very rapid declivity of which terminated close to the foot of the lake.

In the first visit which Saussure made to these caves, in June 29. 1775, the external air was at 79° in the shade, and the thermometer suspended at the extremity of the caves fell to 37°½.

In the second visit (August 1. 1777), the air without being at 72°½, the thermometer fell only to 42° in the cave. These caves are not deep, their bottom is level with the ground, and the cold air comes out from between the pieces of rock against which they are placed, and only at certain points opposite to which they have made holes in the wall of the inner end.

The last caves of this sort, which our learned and indefatigable philosopher has visited, are those of Hergisweil, on the banks of the Lake of Lucerne, in the territory of Underwald, and at the foot of the mountain called Reny, which forms one of the bases of Mount Pilatus. The cold caves are simply little wooden huts, except the back wall, which is built of dry stones, against the accumulation of rubbish at the foot of the rock.

On the 31st July 1783, the thermometer was at 73°.2 in the shade, and at 39°½ in the interior of the hut. The proprietor affirmed to Saussure, that milk could be preserved in it for three weeks, meat for a month, and cherries from one season to another. Near this hut, there was another similar, where they preserved snow, which was sold in summer at Lucerne. This last fact connects very closely the series of phenomena, of which I have just given an account, with those which the natural ice-caves have presented to us.

There is another circumstance which must not be omitted, that in winter congelation takes place a little later in these huts than in the open air, but it afterwards freezes harder in the huts:

"without doubt, (says Saussure,) this is produced by the current which enters into these subterranean cavities."

Further on he adds, "The proprietors of these cold caves unanimously affirmed, that the hotter the summer was, the greater was the strength of the current of air which issued from them, and which re-enters in winter from the intensity of the cold."

We shall also add to this phenomenon another fact equally authenticated, and which points out the cause of the first very distinctly. We know, that in working mines, situated on the declivity of a mountain, after having dug a vertical pit, they join it at the bottom to a horizontal gallery, which opens out to the air. These two cavities, which form a right angle, one branch of which is vertical and the other horizontal, act as a syphon, from which the air issues in summer, from the lower orifice, and rushes in from the top to the bottom of the pit; whilst in winter, it enters, on the contrary, by the gallery, and forms in the pit an ascending current. These two currents, whose direction is inverse, are produced by the different relative weight of two currents of air, which balance reciprocally the one in the pit, the other in the open air, and which have for their base the door of the gallery, and for their common height the depth of the pit.

In summer, the exterior column yields, because being hotter, it is higher than the interior one; and the greater the rupture of the equilibrium of temperature between the two columns, with so much the greater force does the interior column descend and issue from the gallery. In winter, the rupture takes place in the opposite manner. The column in the pit is warmer than the external one, and is pushed up to the top, from below, by the latter, which rushes into the gallery. And, in the intermediate seasons, when the temperature without and within is equal, then there is no movement in the air either way.

There is little reason to doubt, that the same alternations take place, wherever there exist natural cavities, nearly in a vertical direction, terminated below by lateral openings in the form of grottoes. A current of air must be established, which, in summer, will be from above to below. This current brings into the grotto not only the temperature of the vertical portion of the

cavity through which it has passed, but all the refrigerating effect of evaporation, which must be very considerable, if the space traversed is filled with fragments of stone, constantly watered by some little stream.

Such is the most plausible explanation of the cold winds which issue from the grottoes at the foot of Monte Testaceo, and of all the cold caves we have mentioned, and which (it must be recollected) are always placed against some mountain or hill.

Saussure, who suggested this ingenious explanation, wished to ascertain the refrigerating effect which it supposes, by an experiment, which, if it did not shew the highest possible degree, at least proved the reality of it. He filled a glass tube of an inch diameter with fragments of wet stones, and made the air rush through by means of bellows; the air, which was at 72° at its entrance, was at $65^\circ\frac{3}{4}$ when it came out of the tube. He afterwards obtained an additional degree of cold, by directing the bellows against the ball of a thermometer wrapped up in wet linen.

If we suppose the mean temperature of the cavity in which the air thus circulates, to be at 48° or 50°, it will not appear very extraordinary that the refrigerating process of evaporation, favoured by a great multiplication in the surfaces, and by a temperature already cooled by the evaporating water, should attain the freezing point, and in this case the natural ice-caves are only grottoes, with cold currents of air, which are a little colder than others, because the refrigerating effect of evaporation is there more favoured by circumstances. "This explanation of cold currents," says Saussure, "has nothing forced in it, at least for countries near our Alps, which are those where the coldest caves have been observed." We saw the thermometer at $37^\circ\frac{1}{2}$ in the caves of Caprino, and at $38^\circ\frac{3}{4}$ in those of Hergisweil, in the middle of summer. There is not a very great difference between this and the temperature of 48°, which we observed in the ice-cave of St Georges, or of 33° in that of Mont Vergy. It must be observed, that this theory explains very naturally the extraordinary fact, attested by all the inhabitants near the ice-caves, that 'there is more ice formed in summer than in winter.' The reason is a simple one: it is in summer, and in the hottest part of

it, that the destruction of equilibrium is the greatest, between the interior and exterior column of air, which communicate by their base: it is then of course that the current of air, descending and evaporating in the interior, is the most rapid and active, and produces the most powerful effects.

If we admit this explanation as satisfactory, we shall find that Saussure, in endeavouring only to explain the phenomenon of cold winds, has explained likewise, without intending it, that of the natural ice-caves, about which he was not particularly occupied.

By whatever other hypothesis we may attempt to explain the ice-caves and cold winds, that which attributes them to the mass of snow accumulated in the winter, must be excluded. The ice-cave of Brezon is the only one which could be influenced by this cause, but it could have no effect whatever in producing that enormous mass of ice which is worked in the interior of the cavern of St George's, in that of La Baume, or in that of Mount Vergy, which might be worked, if it were situated lower down, and nearer to some city where it would be consumed *.

Art. II.—*Memoir of the Life and Writings of* Olaus Swartz, *M. D., Professor of Botany at Upsal, Knight of the Orders of Vasa, and of the Polar Star, Member of the Acad. Cæsar. Nat. Cur., &c.* By Kurt Sprengel, M. D †.

Olaus Swartz had the advantage of being born of respectable parents, occupying a middle station in society, and received an excellent education. He enjoyed perfect and uninterrupted good health, even to the last years of his life. His sweetness of disposition and inoffensive manners were such, that he felt a glow-

* See this *Journal*, vol. ii. p. 80., for an account of the natural ice-cave of Fondeurle, and also vol. vi. p. 353. We have no doubt that regular crystals of *Ice* will be found in the ice-caves of the Jura and the Alps; and we hope that the examination of these, if they do exist, will be an object of interest to future visitors.—Ed.

† From Nova Acta Acad. Cæsareæ Leopoldino-Carolinæ Naturæ Curiosorum, vol. x. Just published at Bonn.

ing benevolence towards almost all his fellow men, cherished no hatred towards any, was never injured by any, and never gave offence to any.

His attachment to his native country was so great, that he refused the most honourable preferments offered him by foreigners, although he had less reason to be pleased with his salary, than with the honours and estimation conferred on him by all his fellow citizens. His knowledge and acquirements were such, that with *Thunberg* he may be considered as nearly the most eminent botanist of his time. His domestic life was, in as far as we know, tranquil and prosperous, although he had the misfortune to lose his beloved wife eighteen years before his own death. This course of pure and perfect happiness was crowned by a mature age, so that his death will be considered timely, if we look to the completion of honour, and the misery of senile decrepitude; although premature, if we turn our attention to the affection of his friends and the love of his countrymen. Hence, while we have reason to lament his loss, we have also reason to rejoice that his life was useful and happy. But we now proceed, first, to give an account of his life, and then to enumerate the writings which he has left, and which will remain to future times monuments of his knowledge and genius.

Olaus Swartz was born at Norkoping, a flourishing manufacturing town of the Province of East Gothland, on the 21st September 1760. His father, with the intention of completing his education, sent him, in 1778, the year in which *Linnæus* died, to Upsal, the chief seat of learning in Sweden, that he might be more fully instructed in the principles of Natural History. The Younger Linnæus was chosen to supply the place of his father in teaching this science. While attending the prelections of this master, who was constantly afflicted with bad health, Swartz immediately felt that the little knowledge which he gained would soon be lost, did he not turn the vacations, which here occupy nearly the whole summer, to the use of his favourite science. From 1779 therefore to 1782, he travelled at this season through the different provinces, for the purpose of becoming acquainted with their natural productions, exploring those which lie along the Gulph of Bothnia to the west, Lap-

land itself as far as Lulea, Finland, and, lastly, the Islands of Aland and Gothland. When he had acquired, in these journeys, a very comprehensive knowledge of the indigenous plants of his native country, which he increased and perfected by his winter studies, and had remained at the University for five years, being now in his twenty-third year, he purposed to visit foreign countries, in order to augment his store of botanical knowledge. Anxious to investigate the profuse vegetation of the tropics, after he had defended his dissertation *De Methodo Muscorum* (Lin. Amœn. Acad., vol. x., App. p. 69.), illustrated the history of *Gentiana pulchella* (Vetensk. Acad. Hundl. 1783, p. 88.), and communicated his inaugural essay to the Medical Faculty, he left his native country in the summer of 1783, with the intention of visiting North America, in the first place, and in the following year, Jamaica. While in this island, where he remained for upwards of a year, he obtained from the University the degree of Doctor of Medicine *. He continued his journey, which he had undertaken at his own expence, through Hispaniola, and others of the West India Islands, as far as the shores of South America, and every where collected, besides phænogamous plants, ferns, mosses, and lichens, in such abundance, and with so much diligence and sagacity, that his labours in this respect may be compared with those of Sloane, Plumier, and Aublet. At length, in the year 1786, having returned to Kingston, the capital of Jamaica, and after refusing, on account of his attachment to his native country, the Royal Botanical Chair which had been offered him, he embarked in a ship bound for England.

Having finished his voyage in safety, he remained upwards of a year in London, occupying his time in a manner becoming a naturalist, among the natural treasures amassed in that opulent city. Here he received the utmost benefit from the friendship and knowledge of the venerable Sir Joseph Banks, who procured for him ample means of seeing and examining the most extensive

* At this time, the late excellent Dr Wright, F. R. S., &c. was a practising physician in Jamaica, and active in the investigation of its plants. He communicated many plants to Swartz, and otherwise was of great service to that distinguished botanist.

collections of natural objects. After amassing all the knowledge which his excellent opportunities and indefatigable industry could procure for him, he returned home in 1789; and, being immediately honoured with a fellowship in the University of Holm, he renewed his former journeys, and explored, in that and the following year, the northern provinces, the Norwegian Alps, and even part of Lapland. In 1790 he obtained the Presidency of the Academy; and in 1791 the office of Professor in the Bergian Institution. Nearly at the same time he married the daughter of Dr Bergh of Upsal, an amiable and accomplished lady, who died in 1800, leaving him a son and a daughter.

Our author, in the mean time, found consolation in the study of his beloved plants. He refused the honourable situation in the Academy of Petersburg which had become vacant by the death of Lepichinius, being determined to devote his life to the glory and benefit of his own country. Nor was his country ungrateful; for he was advanced to the orders of *Vasa* and of the *Polar Star*: and in 1813 was nominated to a Professorship in the Carolinian Institute. From 1811 he also acted as Secretary to the Academy. Decorated with these honours, and occupied with these labours, he was, in the month of September 1817, seized with a nervous fever, of which he died.

He departed from life, esteemed by all who are devoted to science, loved by every one who loves virtue, courted by the most honourable, whether native or foreigner. "Whatever of Swartz we have loved, whatever we have admired, remains, and will remain in the minds of men for ages to come, recorded in the annals of science and virtue."

His merits are so numerous and so great, especially in Botany, that it would be impossible to enumerate them in a few words, so as to do justice to his memory: For the first and chief accomplishment of a botanist, a very extensive knowledge of the various forms in the vegetable kingdom, was so eminently possessed by him, that we know of none who was his superior in this respect.

He admirably illustrated the family of Orchideæ, which had been left almost untouched to his time, founded new genera, raised upon a fixed and solid basis, and added many new species. (On the genus Epidendron, *Schrad. Journ.* 1799, ii. p. 202.;

on the other genera, *Trans. of the Soc. of Upsal*, vi. 59.; *Vetensk. Acad. Handl.* 1800, ii. p. 202.; *Schrad. neues Journ.* i. 1). Assisted by his efforts and illustrations, R. Brown, and the celebrated Richard, afterwards threw new light upon this family. No one could have better defined and illustrated the characters and species of the genera *Phyllachnes*, (Schrad. Journ. 1799, i. 273.; Annals of Botany, i. 286.): *Forstera*, (ibid. 291), *Ehrharta*, (Trans. of Lin. Soc., vi. 40.): *Stylidium*, (Berl. Magaz, i. 47., v. 89.): *Linconia*, (ibid. iv. 85., v. 283.): *Ochroma*, (Vetensk. Acad. Handl. 1792, 144.): *Stylosanthis*, (ibid. 1789, 295.): *Solandra*, (ib. 1787, 300.): *Chloranthus*, (Philos. Trans., lxxvii. 359.); as well as of many others. In constructing new genera, he was cautious and circumspect, having none of the spirit of innovation which prompts us to elevate every little point of difference to the dignity of a generic character. Acting upon firm principles, he considered those characters only as stable, in which he saw true and essential differences; so that the genera which he established, were never afterwards reduced.

The genera of Phænogamous plants, formed by Swartz, are the following: *Acidoton*, *Ardisia*, *Porosimum*, *Bumelia*, *Calyptranthes*, *Cephaëlis*, *Chloranthus*, *Chloris*, *Coccocypselum*, *Corycium*, *Cranichis*, *Cymbidium*, *Dendrobium*, *Diplodium*, *Dispcris*, *Ernodea*, *Epistylium*, *Hedyosmon*, *Hedwigia*, *Hoffmannia*, *Hypelate*, *Labatia*, *Lacistema*, *Legnotis*, *Leptanthes*, *Linociera*, *Lithophila*, *Meriana*, *Meyera*, *Microtea*, *Myrodia*, *Ochroma*, *Oncidium*, *Petaloma*, *Picramnia*, *Pterygodium*, *Rochefortia*, *Solandra*, *Stelis*, *Stylidium*, *Stylosanthes*, *Tenaëcium*, *Thrinax*, *Tetranthus*, *Tricera*, *Triaxis*, *Valentinia*, *Vanilla*, *Wallenia*. The vast treasures which he had collected in the West Indies, he first described in his *Nova Genera et Species Plantarum*, Holm. 1788; afterwards in the *Observationes Botanicæ*, Erlang. 1791; and lastly, in the admirable work, *Flora Indiæ Occidentalis*, vol. i.–v., Erl. 1797,–1806.

In extricating innumerable new genera and species, elaborating genuine characters, improving them, detecting synonymes, and adding the most beautiful descriptions, he laboured with such indefatigable industry, that he often added figures, delineated by himself, with great skill, as he was sufficiently expert in the art of drawing.

He also added excellent descriptions and illustrations, written in the Swedish language, to the figures published by *Palmsbruch* and *Billberg*, in the *Svensk Botanik*, or Swedish Botanist; at least in the fifth, sixth, seventh, and eighth volumes. In the descriptions of rare plants, he exhibited a specimen of the most acute examination, without prolixity, and without exciting fastidiousness, confining himself to the purest language, and the use of the usual technical terms.

Nor was the application of Swartz limited to phænogamous plants, but, applying himself with zeal to the study of cryptogamic vegetation, he was almost the first of his countrymen who subjected this department of botany to minute investigation. For when he yet attended the demonstrations of the Younger Linnæus, he occupied himself in arranging the *Mosses*, which had been neglected and ill defined by Linnæus himself, and in evolving new characters for them. In which attempt, although, in consequence of following the observations of *Hedwig*, he was entirely deficient in the true and systematic knowledge which he afterwards acquired, he added, however, those important and beautiful *Novitiæ cryptogamicæ*, in which *Splachnum sphæricum*, gathered by himself in Lulean Lapland; *Splachnum angustatum*, *Polytrichum convolutum*, and many other mosses, and even tropical lichens, appeared for the first time. Those mosses which he discovered in his native country, he again described, when residing in the West Indies, in the Nova Acta Ups. vol. iv. p. 239. After this he inserted a *Systematic Arrangement of the Swedish Mosses*, in the Transactions of the Academy (*Vetensk. Acad. Handl.* 1795, p. 223.), which he again published more at large, with beautiful figures of new species, Erlang. 1799, 8vo. In this arrangement, and in his enumeration of West Indian Mosses, he evinced that sagacity and moderation, which every botanist ought to possess.

Although he highly valued the discoveries of Hedwig, he by no means, however, admitted the whole of the genera, which he had separated too artificially, but conjoined, for example, Dicranum and Fissidens, Swartzia and Didymodon, Tortula and Barbula, Bryum and Webera. But then he also established new genera of Mosses: *Cynostomum* (Schrad. neues Journ.

i. 2. 24.), *Cinclidium* (Schrad. Journ, 1801, i. 25.), *Calymperes*, lastly, which Weber published in his Tabula Muscorum, Kilon, 1813.

It is to Swartz, especially, that we owe a more intimate and solid knowledge of the *Ferns*. When he returned from his great journey, he illustrated the genus *Vittaria*, confiding in the observations of Smith (Neue Schriften der Berl. Gesellsch. Naturf. Freunde, ii. 129.) He elaborated a *new systematic arrangement* of this family (Schrad. Journ. 1800 ii., 1801 ii. 273.), in which, besides innumerable new species, he first published the genera *Lygodium*, *Psilotum*, *Botrychium*, and *Grammitis*. His *Synopsis Filicum*, published at Kilon, in 1806, is deservedly admired, on account of its very accurate characters of nearly eight hundred species, its beautiful descriptions and excellent figures. In this work he gave to the world the new genera *Anemia*, *Mohria*, and *Cheilanthes*. Lastly, he increased his reputation by the *Brasilian Ferns*, collected by *Freigreiss*, (Vetensk. Acad. Handl. 1817, p. 53.)

Nor was he deficient in the knowledge of *Lichens*, or even *Fungi*. Of the former, he described many in the *Flora Indiæ Occidentalis*, and *Fasciculus Lichenum Americanorum*, Erlang. 1811; and, of the latter, chiefly the indigenous species, in the Transactions of the Stockholm Academy (Vetensk. Acad. Handl. 1808, 1809, 1810, 1811, 1812, 1815); and added also the new genus *Verpa* (ib. 1815, 129.)

Although less partial to Zoology than botany, he did not, however, entirely neglect this study. He illustrated the *History of Myxine* (Vetensk. Acad. Handl. 1790, p. 114.), of the *White Termite* (ib. 1792, p. 228.), of the *Medusa* (ib. 1788, p. 198., 1791, p. 188.), of the *Pulex penetrans* (ib. 1788, p. 40.), and of *Copicerus*, a new genus of insects (ib. 1802, p. 270.), and inserted several new species of insects in the Synonymia Insectorum of Schönher, p. 2. and 3. Besides, he added descriptions of animals to the figures published by Palmsbruch and Billberg (Svensk Zoologi.)

Although, by these works, Swartz has evinced himself a diligent observer of nature, and especially a most learned and most sagacious botanist; yet he was very fond of those arts which reduced science to practice, and are conducive to public and domes-

tic prosperity. Being particularly addicted to Horticulture, he left a set of manuscript prelections on this art; and also wrote the text of a Swedish periodical work, intended to promote its practice (*Magazin för Blomster-älskare och Jokare af Tradgaärds skötselen, utgifvet af Pfeiffer, Venus och Ruckmann,* 1806, 12 *Häften.*) Lastly, he inserted various remarks on the diseases of plants, and others on useful culinary vegetables, in another periodical work, some of which were translated from the German and French languages, (Landtbruks Acad. Annaler, 1814, 1815, 1816.)

The liberality of this excellent man, free from all jealousy or envy, is celebrated by every one who had any dealings with him in a literary way: with the same benevolence, he transmitted to his friends the rarest plants, as well as the most excellent remarks written by himself.

Some of these, containing species of mosses, lie with *Weber* of Kiel, others, on new mosses, in the cabinet of *Schrader*, at Göttingen, and others, illustrative of American lichens, in that of *Sturm*, at Nuremberg.

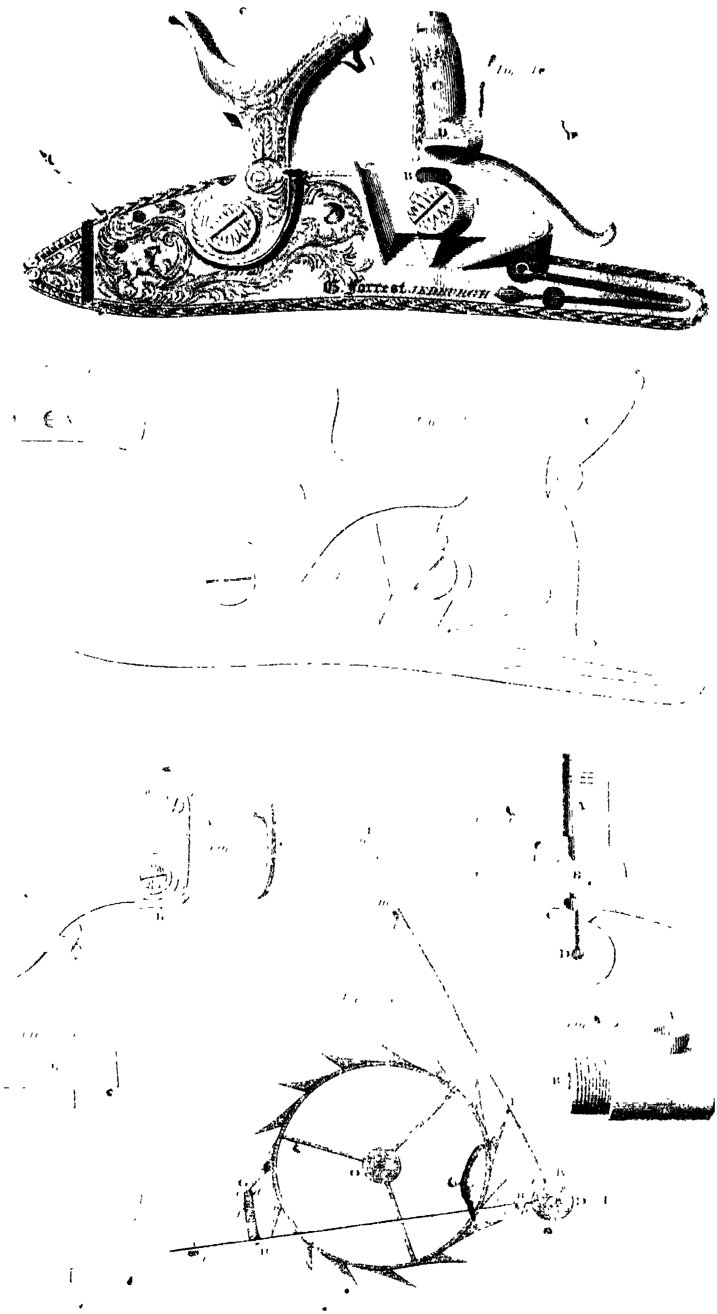
To this illustrious botanist, *Schreber* first dedicated the *Tounatea* of Aublet, which he considered as generically different from the *Possira* of the same author, giving to this latter the name of *Rittera*. But, it being shewn by *Vahl*, that they in reality form only one genus, *Willdenow* retained the name of SWARTZIA. It is a genus of South American trees, belonging to Polyandria; but whose natural affinities are not yet well understood, unless, perhaps, it be related to Schreber's *Dimorpha*, and to *Cyclas*, and be thus referable to the *Leguminosæ*. The genus of mosses to which Hedwig gave the name of *Swartzia*, was afterwards named by him *Cynontodium*.

ART. III.—*Account of a New Percussion Lock*, by Mr GEORGE FORREST, Gunsmith, Jedburgh. In a Letter from Mr LIZARS to Dr BREWSTER.

DEAR SIR,

I BEG leave to send you a sketch and description of an improved *Percussion Lock* by Mr George Forrest, gunmaker, Jed-

PLATE I.



burgh, which, I have been informed, is esteemed by sportsmen to be a very ingenious contrivance, and considerably different from others which have been made upon the same principle. I am entirely ignorant of the properties of these implements, and would not have troubled you with any account of Mr Forrest's improvement, had it not been mentioned to me at the time I saw the fowling-piece, that the celebrated Dr Wollaston had examined it with some interest, while lately on a visit to that place. I was also informed, that it had been tried by the Earl of Minto and his two brothers, who expressed themselves very highly pleased with the ease and certainty of its operations, and the perfect safety with which it may be used.

The chief advantages of this invention, are the great convenience of being enabled to supply as much priming powder before setting out on a day's sport, as (with a double-barrelled piece) will answer for eighty discharges, with scarcely any farther trouble than merely filling the magazine before setting out,—the perfect certainty of the explosions,—the greatest ease in keeping the lock clean and unexposed to a damp atmosphere,—and, above all, the most complete security against every possibility of accident by the explosion of the powder contained in the magazine. These properties I hope will be understood from the following description of the sketch, and, on the inventor's account, I shall be most happy if you shall think it worthy of your notice.

Fig. 1. of PLATE I. is a representation of the complete lock, as seen at half cock. A, a steel punch fixed into the point of the cock, which, when the trigger is pulled, descends into the pan B, in the direction of the dotted line, and, in its sudden descent, strikes upon the hammer C, and removes the hammer (where also the magazine is contained) to the position shewn in Fig. 2. D, a finger-screw, by turning which the proper quantity of priming powder is measured out for a single discharge, and emptied into the pan B. E is that part of the lock through which there is a small perforation leading from the pan to the barrel. This part of the lock will be better understood by examining Fig. 5. which is a lateral view, shewing (by the dotted lines) the canal through which the fire is conducted from the pan A to the barrel at B.

Fig. 2. is another representation of the lock after being fired. This is given for the purpose of shewing how the magazine in the hollow of the hammer C is thrown back, out of the reach of contact with the flash from the explosion in the pan, and in what manner the punch at the point of the cock descends into the pan, when the trigger is pulled to set off the piece.

Fig. 3. is a lateral representation of the finger-screw seen at D, Fig. 1. This view of the figure also shews a steel cylinder, which is interposed between the magazine and the pan, for the double purpose of security against accident from the contact of the one with the other, and for measuring off the proper quantity of powder requisite for one discharge. The small hollow in the cylinder where the priming lodges is seen at A.

Fig. 4. is a section of the magazine, the cylinder, the pan, and the funnel through which the fire is conveyed to the barrel. A is the magazine, B the cylinder, C the pan, D the funnel; E is the small hollow in the cylinder in which the priming powder lodges before the cylinder is turned round by the finger-screw, and emptied into the pan.

Fig. 6. is a representation of the other side of the magazine next to the barrel, where there is placed a spring which catches into a nick at the end of the cylinder, and indicates when the priming powder is emptied into the pan, and when the cylinder is again turned round to its proper position. A is the spring, B the nick, C is the spring, seen apart from the side of the magazine.

I hope it will now be understood, that the excellence of this invention consists chiefly in the well judged intervention and position of the cylinder betwixt the pan and the magazine, which arrangement completely prevents all possibility of any accident; for, by an examination of the diagram, or rather enlarged section of this part of the apparatus, given at Fig. 7., it will be seen, that at no point whatever, during the process of turning round the cylinder to fill the pan, is the powder in the magazine ever brought in contact with that point. Let it be supposed that A represents the hollow of the cylinder where the powder is lodged, and in its present position letting the contents fall into the pan, it is obvious that no communication with

the magazine B can take place in this position; and if we again suppose the hollow turned round to *d*, there is still no communication. In short, Mr Forrest's invention in this respect is so excellent, that even with the greatest neglect and carelessness there is no danger.

The quality of the priming powder is the same as used for Mr Forsyth's patent, 3 parts of the oxymuriate of potash, 1 of sulphur, and 1 of charcoal. I am, Dear Sir, yours most respectfully,

EDINBURGH, 21*st October* 1822. WILL. H. LIZARS.

ART. IV.—*Account of a New Escapement* By Mr DAVID WHITELAW, Watchmaker, 16. Prince's Street, Edinburgh.

THE rewards which have been offered by Government, and the encouragement held out by the public, more particularly that part of it engaged in maritime enterprize, have called into action men of such talents within these last sixty years, that chronometers have been brought to a very high degree of perfection. This has rendered it difficult now to effect any very decided improvement in their construction, though particular parts of them may still be susceptible of simplification.

The escapements of Arnold and Earnshaw have been very generally approved of, and much used in the construction of both box and pocket chronometers. From a consideration of the small imperfections still belonging to these, which occurred to the inventor of this, in the course of his employment in the construction of chronometers, he found, that, by taking advantage of some well-known mechanical principles, improvements might still be effected in easing the balance, and diminishing the effects of friction in the escapement, by means of the following construction, in the description and investigation of the principles of which, its advantages over that of Earnshaw will be pointed out.

In this escapement, the teeth of the scape wheel may be those of the common detached ratchet kind, since a small part

of the point of the tooth only is employed, and that slides along an arc of a circle.

Let CLG be this wheel, in which AGHB, Plate I. Fig. 8., is the new method of escapement, and IMLK, that of Earnshaw, each being in a state of repose. Also EF, the diameter of the impulse-pallet, is about $\frac{3}{4}$ths of OC, the radius of the scape-wheel, or nearly a mean between those of Arnold and Earnshaw. AB is a straight cylindrical lever, turning about an axle passing through H, whose ends work in jewelled holes in the frame of the watch as usual, to give a steady motion, and as little friction as possible. GH, whose shape may be varied, is a detent fixed to AB, on which the wheel rests, in such a manner that the angle OGH is a right angle, and GH is consequently a tangent to the wheel at the tooth G. The part or face *cd* is jewelled, and formed into an arc of a circle, of which the radius is GH; and therefore, when it slides along the tooth G, it can give no motion to the escape-wheel; also *ab* is the slight spring fixed at *a* as usual.

Now, BGH may be considered as a bent lever, or as a wheel and pinion fixed on the same axis as H. Hence, any power applied at B is to the resistance at G as GH is to BH, or $G \times GH = B \times BH$ by mechanics *. Hence, if we suppose GH to be $\frac{1}{4}$ of BH, the power will be to the resistance as 1 to 4; or $\frac{1}{4}$ of power applied at B, will equal the resistance from friction, and the force of the slender spring employed for bringing the detent into its proper position upon the tooth of the scape-wheel at G.

Now, in the case of Earnshaw's, if we conceive the bar IK to be a lever fixed at I, and turning or bending round M, the middle of the spring *em*, as a centre, which is nearly true, L the stud, or detent, in which the tooth of the scape-wheel acts as before, *ik* the slight spring fixed at *i*, then this will become a lever of the second kind, and we have by mechanics †, the power applied at K, is to the resistance at L, as LM is to KM, or $K \times KM = L \times LM$. Hence, if KL is $\frac{1}{4}$ of LM, as formerly supposed, then the power applied by the balance at K will be

* Wood, § 96. prop. xviii.—Gregory, vol. i. § 133. cor. 4.

† Wood, § 73. prop. xiv.—Gregory, vol. i. § 133. cor. 3.

to the resistance from friction, &c. at L, as 4 is to 5, instead of as 1 to 4 by the new escapement. It is evident, too, that much more force will be required to bend the spring *em*, which must be of sufficient strength to resist the whole force of the scape-wheel in Earnshaw's, than to overcome the friction of the pivot-holes at H, and the force of the tender spring at *f*, and consequently another advantage is gained by this method, perhaps not less than the former. Indeed, the less LK is in proportion to LM, it is obvious the less is the advantage gained in Earnshaw's; whereas in this, the less GH is in proportion to HB, so much the more is gained, and that in any given proportion, since the impulse-pallet is placed on one side of the scape-wheel, and the detent on the other. Since, in the new escapement, the impulse or power is to the resistance as 1 is to 4, and in Earnshaw's they are in the ratio of 4 to 5, the advantage gained by Earnshaw's method is only one-fourth of the whole, whereas in this it is three times the whole. It is also apparent, that the whole force of the scape-wheel bears upon the centre H, since *cd* is an arc of a circle; and hence the difficulty of forming the spring *em* of the proper thickness absolutely necessary to support that force is thereby avoided. The locking by this method is also much more sure and steady, when resting on a centre, than in the case of Earnshaw's, which is upon a slight spring. The detent GH is brought into its proper position, by means of a very delicate spring, acting at about *f*, as before stated, on the jewel, which is fixed there chiefly to receive the tooth of the scape-wheel; or it may be done by a spiral or helical spring attached to the axis at H, somewhat in the form of a balance-spring, which, by an adjustment, may perhaps have a slight influence in bringing the chronometer to time.

EDINBURGH, *Sept.* 1822.

ART. V.—*On the Calcareous Tufas of Hungary.* By F. S. BEUDANT, Chevalier of the Royal Order of the Legion of Honour, &c.

RESTING over deposits of the secondary and other older rocks, there appear, on the one hand, the crystalline sediments, or *tu-*

fas, which are daily formed by chemical precipitation from matters which the waters dissolve, while traversing the mineral masses; and, on the other, the heaps of different matters, continually detached from the mountains, which the waters of rains, torrents and rivers, daily extract from all parts, and carry to the bottom of the neighbouring valleys, or transport, in their course, to the midst of distant plains. It is these latter deposits, whose mass is always increasing, which, after being once formed, are again themselves affected by the waters, transported from one place to another, undergoing various changes, that I would more particularly designate by the name of Alluvion. They form, in some measure, the continuation of the arenaceous deposits which have been already described, and which may be regarded as colossal alluvia of an old world. It is even sometimes difficult to distinguish them, because they are the same materials, which, after having been worn off in one point, have been transported without any change to another. But the difference which exists here is more easily perceived than expressed; and besides, in these deposits, there occur enveloped together, debris of all sorts, derived from various kinds of rocks over which the waters have rolled, plants which grow at the surface of the soil, terrestrial or aquatic shells of all kinds; debris, in short, of all that exists at present upon the earth, whether natural productions, or even the products of human ingenuity. There result, in consequence, deposits which are distinguished from all others by a multitude of peculiar circumstances.

Among the calcareous tufas which occur in Hungary, two species should, perhaps, be distinguished; one which proceeds from old deposits, of the formation of which no remembrance is preserved, and which, having long since ceased to increase, appear to have belonged to an ancient order of things; another, again, which comprehends deposits evidently originating from sources which are still to be discovered in the same places, and which do not cease to acquire daily augmentations in the same manner as they have commenced. To the first type must be referred the calcareous tufas which occur above the last houses of the suburb of Buda, and which extend from thence to the gravelly hills of Saint André. It is a pretty considerable mass, which terminates in a very even platform, the sides of which are

escarpés à pic to a moderate height, at the edge of the little plain of Old Buda. The lower part is a coarse tufa, of a yellowish-white colour, full of infiltrations of calcareous spar which here and there forms brilliant veins in the midst of the rock, or even stalactites in the cavities which abound in its substance. In proportion as we proceed upwards, the tufa becomes more compact; and in the upper parts, it presents an extremely solid, and very hard rock, with a splintery fracture, perforated with irregularly tubular holes, sometimes empty, sometimes crusted, or even filled with white transparent calcareous spar. I have distinguished, in some parts, vegetable impressions, helices, and other shells which appear to belong to the genus paludina, and to the species designated by the name of paludina impura. These deposits of calcareous tufa have been wrought in many points as a building stone, especially in the more solid parts. The works have been carried on, as it would seem, for many ages; for these stones have been used in some parts of the fortress of Vissegrad, which shows, that, at the period when that fortress was built, the tufas in question were nearly such as we see them at the present day. I have discovered no trace of the springs from which they have derived their origin; and nowhere have I observed modern augmentations made to the mass.

It was without doubt, also, at a very remote epoch, that the calcareous tufas were formed, which we see on the western side of Bloksberg, and which are particularly remarkable on account of the planorbes which they contain in certain points. These tufas are very solid, of a whitish or yellowish colour, and have, in some parts, a great analogy with the Travertino of the neighbourhood of Rome, which is also an ancient tufa. No traces of the waters from which these masses have been deposited, are to be seen now at Bloksberg: it is probable that they were formed at a time when that mountain was altogether different from what it is at the present day. The presence of planorbes indicates, that there were other waters than those of an incrusting spring, which might be imagined upon the sides of the mountain; there must have been a stream or body of fresh water of some kind, where the planorbes could have lived; and at the

present day, it would be impossible for the one or the other to exist, on account of the form of the mountain.

With regard to the deposits of tufas, formed by springs which still exist at the present day, in the same places, and which continually augment the mass in a greater or less degree, there occur a very great number in Hungary. All the calcareous mountains of the counties of Trentsen, Thürotz, Arva, Lipto, Zolyom, &c. abound in acidulous springs, which deposit a great quantity of carbonate of lime, and of which some have formed in various points, masses so considerable, as in many cases to induce the belief that their waters were infinitely more abundant than they are at the present day. In fact, the present increase of these deposits is extremely slow; and were we to calculate, on the same basis, the period of time necessary to form such a mass, we should, without doubt, find it by much too considerable. It appears that there has been a certain period of rapid increase, after which the formation has abated to the point at which we see it at the present day. It is even to be presumed, that this period is already very remote; for the large hills of tufa have, in the detrition of their surface, and in the manner in which they are covered, either with gravel, or with vegetable soil, &c. a certain air of antiquity, something which seems to say that their origin must extend to many ages back. It is besides to be remarked, that there exist, on many of these hills, churches which appear very old, ruined castles, &c.; and, as I have been assured, there are some which are mentioned in extremely old acts and records. An inquiry into these details, not only in Hungary, but in many other countries of Europe, might be the object of an investigation very interesting for the geology of later ages.

The deposits which are daily forming in the marshes of the great plain, and which we have already described, should be still regarded as true tufa; for, although some parts of these deposits may be owing to a mechanical precipitation of earthy particles, there certainly exists also a crystalline sediment for producing the solid and compact parts which are used in the plain for building. But there is here this difference, that the crystallization takes place tranquilly under the water, while, in the former deposits of tufa, it is the result of a continual evaporation in the open air, and of the disengagement of carbonic acid, by means

of which these waters held the greater part of carbonate of lime in solution. It results from this, that the deposits of the marshes are rather geological formations than the others; and, in fact, the mineralogical characters which they present, bring them much nearer in nature to various mineral beds of the tertiary formations than any of the former tufas, even of those which are the most solid and most ancient.

It is these waters, charged with calcareous particles in solution, and at the same time with mud simply suspended, which often agglutinate on the declivity of mountains the small fragments of all kinds detached from the neighbouring rocks. There result kinds of breccia or puddingstone, having very little solidity, which are pretty commonly found in the high mountains, and of which Hungary also presents many examples, especially in the counties of Zolyom and Lömör. But no where do these modern deposits form in considerable masses, which may perhaps be owing to this, that, being always rather soft, they crumble down after they have arrived at a certain height. We are so much the more induced to form this idea, that we often find pretty large detached blocks, more or less broken, on the declivity of the mountains, or in the bottom of valleys, and that it is rare to find, *in situ*, masses of greater size. One of the best points which I know in Hungary for verifying these observations, is the route from Neusohe to Henengrund, keeping along the declivity of the mountain.

Art. VI.—*On the Use of Perfumes in preventing the Formation of Mouldiness.* By John MacCulloch, M. D. and F. R. S. &c. Communicated by the Author.

There are many cases of daily occurrence, in which the growth of those minute vegetables that constitute mouldiness, is a very troublesome inconvenience. As your Journal does not despise the useful, I need make no apology for a communication that has no other quality to recommend it.

I do not pretend to account for the mode in which perfumes act in producing this effect; nor do I know the limitations with respect to these: but I have found it hold good with all the es-

sential oils that I have tried, and that even when used in a very minute quantity.

Ink, paste, leather, and seeds, are among the common articles which suffer from this cause, and to which the remedy is easily applicable. With respect to articles of food, such as bread, cold meats, or dried fish, it is less easy to apply a remedy, on account of the taste. Cloves, however, and other spices whose flavours are grateful, may sometimes be used for this end; and that they act in consequence of this principle, and not by any particular antiseptic virtue, seems plain, by their preventing equally the growth of those minute cryptogamous plants on ink, and other substances not of an animal nature.

The effect of cloves in preventing the mouldiness in Ink, is indeed generally known; and it is obtained in the same way by oil of lavender, in a very minute quantity, or by any other of the perfumed oils.

To preserve Leather in the same manner from this effect, is a matter of great importance, particularly in military store-houses, where the labour employed in cleaning harness and shoes is a cause of considerable expence, and where much injury is occasionally sustained from this cause. The same essential oils answer the purpose, as far as I have had an opportunity of trying effectually. The cheapest, of course, should be selected; and it would be necessary to try oil of turpentine, for this reason. The total interruption of all my pursuits has hitherto prevented me from carrying these trials as far as I intended.

It is a remarkable confirmation of this circumstance, that Russian leather, which is perfumed with the tar of the birch-tree, is not subject to mouldiness, as must be well known to all who possess books thus bound. They even prevent it from taking place in those books bound in calf near to which they happen to lie. This fact is particularly well known to Russia merchants, as they suffer bales of this article to lie in the London docks in the most careless manner, for a great length of time, knowing well that they can sustain no injury of this nature from dampness, whereas common curried leather requires to be opened, cleaned, and ventilated. Collectors of books will not be sorry to learn, that a few drops of any perfumed oil will ensure their libraries from this pest.

I had commenced some trials on Wood on the same principle, with the view of preserving it from what is called the dry-rot, and, as it seemed to me, with effect. But as I have now no hopes of pursuing this subject, I am glad to have an opportunity, by your means, of putting it into better hands. A cheap oil, of course, would be required for operations so extensive as this.

The next substance that I shall point out is Paste, which is a very perishable article. Alum, which is used by the bookbinders, although it preserves that most necessary substance longer than it would remain useful without it, is not very effectual. Rosin, sometimes used by shoemakers, answers the purpose better, and appears to act entirely on this principle. It is, however, less effectual than even oil of turpentine. Lavender, and the other strong perfumes, such as peppermint, anise, and bergamot, are perfectly effectual, even in a very small quantity; and paste may thus be preserved for any length of time.

Your mineralogical readers in particular, who have frequent occasion to use paste for their labels in very small quantities, and where the trouble of thus making it on every fresh occasion is inconvenient, will be glad to know that this useful article may be made to keep, even for years, always ready for use, and subject to no change.

That which I have long used in this manner is made of flour in the usual way, but rather thick, with a proportion of brown sugar, and a small quantity of corrosive sublimate. The use of the sugar is to keep it flexible, so as to prevent its scaling off from smooth surfaces; and that of the corrosive sublimate, independently of preserving it from insects, is an effectual check against its fermentation. This salt, however, does not prevent the formation of mouldiness. But as a drop or two of the essential oils above mentioned is a complete security against this, all the causes of destruction are effectually guarded against. Paste made in this manner, and exposed to the air, dries without change to a state resembling horn; so that it may at any time be wetted again, and applied to use. When kept in a close-covered pot, it may be preserved in a state for use at all times.

This principle seems also applicable to the preservation of seeds, particularly in cases where they are sent from distant

countries by sea, when it is well known that they often perish from this cause. Dampness, of course, will perform its office at any rate, if moisture is not excluded; yet it is certain, that the growth of the vegetables which constitute mould, accelerate the evil; whether by retaining moisture, or by what means, is not very apparent. This, in fact, happens equally in the case of dry rot in wood, and, indeed, in all others where this cause operates. It is a curious illustration of the truth of this view of a remedy, that the aromatic seeds of all kinds are not subject to mould, and that their vicinity prevents it in others with which they are packed. They also produce the same effect daily, even in animal matters, without its being suspected. Not to repeat any thing on the subject of cookery, I need only remark, that it is common to put pepper into collections of insects or birds, without its having been remarked, that it had the same power of keeping off mould, as of discouraging or killing the *ptinus omnivorus*, or other insects that commit ravages in these cases.

In concluding these hints, I might add, in illustration of them, that gingerbread and bread containing carraway-seeds is far less liable to mouldiness than plain bread. It will be a matter worthy of consideration, how far flour might be preserved by some project of this kind.

Art. VII.—*Notice respecting an ancient Ship discovered in a Garden at Stranraer, in Galloway.* By Alexander Kennedy, M. D. F. R. S. E. &c. &c. Communicated by the Author.

The accompanying very curious notice, of the discovery of an ancient ship, I copied, some time ago, from a manuscript account of the Bishoprick of Galloway, in the possession of Thomas Goldie, Esq. of Dumfries. Who was the author of the manuscript is not known.

The ship was discovered at Stranraer; and of the particulars recorded regarding that parish, I need only advert to that which mentions the Bishop of Galloway as being the patron of it. This fixes the composition of the manuscript previous to the abolition of Episcopacy in Scotland; and, if I mistake not,

it elsewhere bears internal evidence of having been written subsequent to the year 1670.

The passage regarding the ship is as follows:

"In this town (Stranraer), last year, when they were digging a water-gate for a miln, they lighted upon a ship, a considerable distance from the shore, unto which the sea, at the highest spring-tides, never comes: It was (lying *) transversely under a little bourn, and wholly covered with earth, a considerable depth; for there was a good yeard, with kail growing in it, upon the end of it. By that part of it which was gotten out, my informers, who saw it, conjecture that the vessel had been pretty large; they also tell me, that the boards were not joyned together after the present fashion; and that it had nailes of copper."

It is much to be regretted that this discovery had not been inspected by more curious eyes, and the particulars more accurately recorded. The nails of copper, almost irresistibly lead back the mind to a very remote period.

The conjecture regarding the size of the vessel, having been formed from "that part of it which was gotten out," would imply that the whole of it was not removed or uncovered; and if so, as there appears no great improbability in supposing that the materials which had endured from the remote ages when copper-nails were used for such purposes, may also have withstood the decay of 140 or 150 years longer, the remains of the vessel, which were left *in situ*, if not since removed, might perhaps still be recoverable.

Edinburgh, 1*st October* 1822.

ART. VIII.—*Further Remarks connected with the Physiology of the Fibres of the Root.* By JOHN MURRAY, F. L. S. M. W. S. &c. &c. Communicated by the Author.

NUMEROUS are the phenomena that might be reasonably appealed to, in corroboration of the opinion which opposes the al-

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* This word is omitted in the copy taken for me, but there can be no doubt about the sense.

most universally received one, namely, that the fibres of the root are absorbents, and the canals which convey the proper food of plants to the vegetable system.

Besides the *Epidendron* which grows on the stem of the *Sterculia Balanghas*, we find the *Dendrobium Picrurdii*, which succeeds very well if fastened to a tree, and artificially irrigated. Some species of *Orchis* grow luxuriantly on the barren rock. I have preserved leaves of the *Bryophyllum calycinum*, fretted with *young plants* around its indented fringe, for *fourteen months* in my pocket-book.

The lateral branches of a tree on one side, which over-arched a rich compost, were, compared with those on the other side, remarkably luxuriant; and if the branches be carried *over a wall*, and the soils on either side differ in quality, the tree will exhibit a corresponding variety. Moreover, the same luxuriance and permanence are exhibited in meadow herbage, whether the manure be scattered over the superficies, or applied immediately to the roots.

Kirwan, in his Geological Essays, has adverted to experiments, which prove, that the fertility of a soil has reference to its relations to moisture, rather than any thing else.

In Captain Tuckey's "Narrative," London, 4to, 1818, p. 18. is the following remark, made at *Porto Praya*: "A very large tamarind tree, growing out of the crevice of a naked rock, and the profusion of fruit on the cocoa-nut, banana and papaw trees, where there is not a foot of soil, prove, that in this climate *water* is the grand principle of vegetation."

I saw a very interesting phenomenon connected with the preceding facts, at Arley Hall, the seat of the Earl of Mountnorris. A *Cactus triangularis* had grafted on it, two of the *C. phyllanthoides*, about a foot distant from each other; also one of the *C. flabelliformis*, about 7 feet high on the stem; and one of *C. grandiflorus*, say 4 feet distant from the latter. The *C. flabelliformis* has been inserted three years, and has flowered much finer *than when growing on its proper roots*. The others have been attached not more than a year and a-half, and have not yet flowered. No fibres appear at the point of insertion.

Another plant of *Cactus triangularis* had extended itself to a

considerable distance along the wall. One of the branches let down a long root, and when it had descended *five feet*, it subdivided into smaller ones: at 14 inches from this subdivided point, they reached a pot, which they seized on, and fastened therein; the branch was now separated from the parent plant, and continues in health and vigour. The main root has not changed its character, which is the case with some plants, and where the roots, thus exposed, become a stem that issues in branches.

This last curious phenomenon reminds us of the *Plane-tree*, which, from the summit of one of the ruined walls of *New Abbey* in Gallowayshire (mentioned by Lord Kames), detached a root to the soil below.

To preserve the healthy functions of the plant, the excretory ducts must be preserved soft, and uniformly free; and this is as essential as the supply of the absorbent vessels. The tips of the fibres of the hyacinth, for instance, are more opake and dense than the other parts, and from hence the fibres elongate; for if such be cut off, the fibres remain stationary at that length.

Fresh water is necessary. The water-cress (*Nasturtium officinale*) must be in a constant current, else the plant does not thrive; and when parallel with the stream, it succeeds best.

Water is essentially necessary, even to the preservation of the vitality of the seed, in some cases. In the *Trapa natans*, the fruit inclosing the seeds falls into water, and the seeds must be carried immersed therein, where they will root, otherwise the vegetative power would be unhinged.

It is quite unnecessary to quote more examples, illustrative of the necessity of a supply of fresh-water, to preserve alive the healthy functions of the plants. The quantity may vary in different plants, but *some* is always necessary, whether supplied by the soil or the atmospheric medium.

It must not be conceived that I have spoken of any other than the *mere fibre* of the root. The *tuber* and the *bulb*, and the *base of the trunk*, *may* perform a different character.

The *Gloxinia speciosa*, and *Gesnera bulbosa*, grow freely from leaves, and form *bulbs*.

The *Phleum pratense* becomes, in a fluctuating soil, the *Phleum nodosum* of some authors, while, in a wet soil, the plant is entirely fibrous and luxuriant.

Sir James E. Smith found the *Alopecurus geniculatus* (a root naturally *fibrous* and *repent)* possessed of an ovate juicy bulb, on the summit of a dry wall. The changes adverted to are essentially connected with a relationship to water, and have evidently nothing to do with grosser materials.

When a bean reposes for some time in distilled water, it swells, yet it is still *questionable* whether water be absorbed; the testa is evidently *impervious* to water, and the *great decrease in its specific gravity* (a fraction heavier only than distilled water) proves, that if any be absorbed, the quantity is very small, and the *chief* purpose it seems to serve, is that of unsealing the orifice, by dissolving the albumen, and softening the membranaceous capsule or *testa*. This allows the carbonic acid, developed during the expansion of the plumula, to escape.

I took two bottles of water from the cisterns which contained *aquatic plants*, in the conservatory at Arley Hall.

That from the cistern which was most *foul and stagnant*, was submitted to chemical examination. Six fluid ounces, treated with lime-water, yielded a precipitate, which proved to be carbonate of lime. When dried, and carefully weighed, it was =.50 grains; therefore afforded .22 gr. carbonic acid gas.

Six fluid ounces submitted to the action of heat, yielded .64,5 cubic inches of air, in which a taper *burnt dimly*, exhibiting a *slight deterioration*; and when the quantity of decomposed vegetable matter in this cistern is considered, and in which the *pots, soil, roots*, &c. were immersed, it affords a strong argument in favour of the important part sustained by aquatic plants.

This cistern contained *Arum collocasia, esculentum*, and other species. Also the *Eryngium aquaticum*, &c.

The cistern where the water seemed most pure and diaphanous, was filled with *Nymphæa odorata, cærulea*, also *Menyanthes exaltata*, and *nymphoides*, &c.

Six fluid ounces, mixed with lime-water, gave, in this last, —.25 gr. which = —.11 gr. carbonic acid gas.

By heat, the same quantity yielded, cubic inch. .30 of a gas; on continued ebullition, a taper plunged into it, *burnt in all respects as in common air*; consequently it was not materially vitiated.

No doubt, the water in both cisterns must have been deteri-

orated by *aquatic animals*, of which there were myriads in constant motion. Now, as rain-water was only *sometimes* employed, and *pump-water* not unfrequently used (which may, perhaps, contain carbonic acid gas, or a super-carbonate), I must assume the whole as warranting my previous conclusions, especially when conjoined with the stagnant atmosphere of a conservatory constantly surcharged with the gaseous products of *decaying leaves*, &c.

ART. IX.—*Remarks on the Increase of the Population of the United States, and Territories of North America, with Original Tables deduced from the American Population Returns, to illustrate the various rates of Increase in the White Population and Slaves, and also the comparative degrees in which Agriculture, Commerce, and Manufactures prevail.* By GEORGE HARVEY, Esq. Member of the Astronomical Society. Communicated by the Author.

THE following paper owes its origin to a desire of inquiring into the growth and progressive augmentation of the population of the United States, and territories of North America. The subject is important, and connected as it is with so many other interesting objects of investigation, it cannot but have awakened the curiosity and attention of every one engaged in the cultivation of statistical science. In England, and perhaps in most other European countries, it is difficult to form a perfect estimate of the causes which have contributed to the rapid increase of the American population, and to the successful advancement of the different states and territories of that portion of the globe, in arts, manufactures and commerce; and it was principally with the hope of obtaining more correct information from some of the active and enlightened philosophers on the other side of the Atlantic, who, from their habits of personal observation, are so well qualified to throw a light on the imperfect elements, with which we at present happen to be furnished, that this essay is now submitted to the readers of the Edinburgh Journal.

The object, which it is hoped has been kept steadily in view in the composition of this paper, has been to admit no other principle or conclusion, than what a careful analysis of the popu-

lation returns of America would afford; and to endeavour to trace through all its states and territories, the degrees in which their diversified rates of increase have prevailed; and, by examining the various ages, and following all the shades and varieties which their different increments and decrements afford; and comparing, as far as circumstances will allow, the situation of the sexes, in their opposite states of slavery and freedom;—to form some estimate of the actual condition of the American population, as far, at least, as statistical tables, like those under review, are capable of affording.

In order to place the subject in a clear point of view, I have found it necessary to compute several tables, which will be introduced in their proper places. The sources from which these have been derived, are the "Tables of the American Census," contained in Godwin's "Enquiry concerning Population," and which that author obtained from "Pitkin's Statistical View of the United States;" and an account of the census for 1820, contained on a single sheet, kindly furnished me by my friend and townsman, Mr Wills.

Before entering on an analysis of these tables, it may not be uninteresting to offer a few remarks respecting the different surveys which have been taken of the population of the United States.

The first authorised census took place in August 1790, the returns for which, when contrasted with those lately published as the result of the census of 1820, will not only furnish the most evident proofs of the rapid increase of the American population, but also of the advancement which has been made by the government of that country, in enlarged and proper views of the objects of statistical science. Previous to the year 1790, no information existed respecting the precise amount of the American population. In 1731 it was supposed, by Dr Franklin, to amount to a million; and Mr Pitkin estimates it at 1,046,000, for the year 1749. If these accounts can be relied on, it would seem as if little or no increase was made in the population during eighteen years; a supposition certainly not to be reconciled with the rapid increments which succeeding years have disclosed.

In the census of 1790, the inhabitants were divided into the following classes, viz.

First, Free white males under sixteen years of age.
Secondly, Free white males of sixteen years, and upwards.
Thirdly, Free white females of all ages.
Fourthly, All other free persons,
Fifthly, Male and female slaves.

The result of this census gave a total population of 3,929,326.

The next census took place in 1800, when several important improvements were introduced. The free white males and females were each divided into the five following classes, viz.

First, All those under ten years of age.
Secondly, All those of ten, and under sixteen.
Thirdly, All those of sixteen, and under twenty-six, including heads of families.
Fourthly, All those of twenty-six, and under forty-five, including heads of families.
Fifthly, All those of forty-five, and upwards, including heads of families.

This division of the ages, although not embracing all the objects of a perfect statistical table, must still be regarded as a great improvement on the objects of the former census; and it was a considerable step, considering the slow march of information on these subjects, at once to divide both males and females into five classes, when, in the census of 1790, the former sex was divided only into two classes, and the latter was taken in one mass, without any distinction of age. This was an advantage, because it enabled statistical enquirers to estimate the increments which each sex had received, in the different periods of existence afforded by the classification, and thus to institute a comparison with other surveys of a like kind. The classes in the census of 1790, relating to "other free persons," and to "slaves," remained unaltered. The result of this census gave a total population of 5,309,758 persons.

In the year 1810 another census took place; but the classes into which the people were divided, and also the different subordinate divisions, remained the same as in 1800. The result gave a total population of 7,239,903.

In the census of 1820, however, the elements of some very important branches of statistical science were introduced; and the survey assumed a much more interesting and scientific form than either of the preceding. In the first place, the five classes, into which the free white males and females were divided in the enumerations for 1800 and 1810, were preserved; but the free white males, between sixteen and eighteen, were selected from the class which embraced the males from sixteen to twenty-six,

and placed in a separate column. This, it may be presumed, was done for the purpose of shewing the power which the country possessed, in this very important class of persons; consisting, as it does, of young men in the prime of youth, and ready for the service of the state in almost every form.

That unfortunate part of the American community, the slaves, which in the former enumerations had been thrown into one mass, without any distinction of age or sex; in this census were divided into classes, embracing both these particulars. Each sex was separated into four classes, of the following ages:

First, All those under fourteen years of age.
Secondly, All those of fourteen, and under twenty-six.
Thirdly, All those of twenty-six, and under forty-five.
Fourthly, All those of forty-five, and upwards.

The classes relating to the ages of the slave population, it is to be regretted, do not correspond with those of the free population; but they agree with another numerous class of persons in the United States, called "free coloured persons," the divisions of whose ages correspond with those of the slaves.

Another interesting and valuable addition to this census, is an account of the number of persons engaged in agriculture, commerce and manufactures, in each state and territory, and from which many interesting particulars may be deduced, respecting the comparative wealth, commercial activity, and internal resources of the different provinces. These additions to the objects embraced in the antecedent surveys, give room to hope, that succeeding enumerations of the American people will still better fulfil the objects which the cultivators of statistics have in view. Much remains yet to be done respecting the classification of the ages, and the introduction of such particulars as are calculated, from their nature, to throw a light on the great objects of the science. It is difficult, indeed, to conceive, to what cause the present division of the ages owe their origin. They certainly do not accord with such a classification, as an enlightened philosophy would suggest. The divisions ought at least to have been into classes of tens, above twenty years of age, and into classes of fives below the same age. Such a classification would have afforded the elements of much important information. If, indeed, the divisions could have been made into classes of fives, from a period of birth to the close of life, similar to the enlight-

ened and philosophic divisions employed in Sweden, some comparison might with safety have been made, between the increase of the inhabitants of the New World, and the authentic returns of a country, which has for so long a period nursed and fostered its population.

Great advantages result to mankind from inquiries of this kind. They admit of a practical application to many of their wants; and to the philosopher they afford the only perfect means of tracing with accuracy and precision, the important questions connected with the doctrine of population. It is pleasing to witness the growing intelligence which now pervades even the lowest classes of the community, with respect to this interesting subject *. A spirit of inquiry has been awakened, and the clouds of prejudice and error, which formerly enveloped amost every step of its course, begin to disappear. Not only for the interests of science, but for the benefit of mankind in general, it is to be hoped, that the elements of a perfect system of statistics will be gradually introduced, not only into the United States, but also throughout Europe; that more just and enlightened notions may be entertained respecting the laws which influence population; that the inhabitants, the arts, manufactures and commerce, of different countries, may be more readily compared

* Of the interest felt by all classes in the populous district of our island in which I reside, I had numerous opportunities of observing, during the time the census of 1821 was taking. The district to which I here allude is Plymouth. A few days prior to the time fixed for ascertaining the population, a number of gentlemen who were likely to feel an interest in the subject, were invited by the Mayor, at my suggestion, to attend a meeting, for the purpose of considering the propriety of assisting the overseers in ascertaining the population. The proposition was acceded to, and the town was divided into a number of small districts, and two gentlemen appointed to each. The public attention was called to the subject by a notice, explaining, in a clear and familiar manner, the nature of the measure, and pointing out the advantages that would particularly result to the lower classes, by enumerations of this kind, from their practical application to Benefit Societies, &c. The consequence of this appeal was, that the utmost readiness was displayed by *all ranks*, in furnishing the ages, the number of each sex, their employments, and such other particulars as the conditions of the census required. In a great many instances, these particulars were left on slips of paper by the heads of families with their servants, to prevent delay. The returns were most accurate and satisfactory, and proved the interest the people felt in the measure, when its nature was properly explained to them. I mention the circumstance here, because, at a future time, other towns may be induced to follow the example.

with each other; and that a liberal and comprehensive policy may arise, embracing, in one grand and magnificent system, all the civilised nations of the earth.

From the statements of Dr Franklin and Mr Pitkin, and the authorised population returns, the following rates of increase have been computed:

		Per Cent.
Increase of the whole Population from	1731 to 1749, - -	4.6
	1749 to 1790, - -	275.5
	1790 to 1800, - -	35.1
	1800 to 1810, - -	36.1
	1810 to 1820, - -	32.9

The first and second rates of increase must be regarded as purely hypothetical; and I should consider, that either Dr Franklin or Mr Pitkin must have made a considerable error in the statement of the population. The rates of increase are so very discordant, that they cannot be by any means reconciled with each other. In eighteen years, for instance, the increment was only 4.6 *per cent.*, whereas in forty-one years, it amounted to 275.5 *per cent.* The three last increments, therefore, are the only ones which can be relied on.

The following Table contains the results of the various rates of increase which the different states and territories have received since the census of 1790, and was computed from the returns of population before quoted. The first column embraces the names of the states and territories, and the succeeding columns the several rates of increase which these provinces have undergone, during the periods indicated at the head of the Table.

States and Territories.		Increase *per cent.* from 1790 to 1800.	Increase *per cent.* from 1800 to 1810.	Increase *per cent.* from 1810 to 1820.
North. States.	Maine, ...	57.2	50.7	30.4
	New Hampshire, .	29.6	16.6	13.9
	Massachusets, .	11.6	11.6	10.9
	Rhode Island, . .	0.4	11.3	7.9
	Connecticut, . .	5.5	4.4	5.1
	Vermont, . .	80.6	41.1	8.2
Middle States.	New York, . . .	72.3	63.6	32.7
	New Jersey, . .	14.7	16.3	13.0
	Pennsylvania, . .	38.7	34.4	29.5
	Delaware, . .	8.8	13.1	0.1
	Ohio, . . .	27.1	408.7	15[illegible].9
	Indiana, . . .	—	334.[illegible]	500.2

	States and Territories.	Increase *per cent.* from 1790 to 1800.	Increase *per cent.* from 1800 to 1810.	Increase *per cent.* from 1810 to 1820
Southern States.	Maryland,	10.7	7.5	7.0
	Virginia,	17.7	10.7	9.3
	North Carolina,	21.4	16.2	15.0
	South Carolina,	38.7	20.1	18.1
	Georgia,	97.1	55.2	35.1
	Louisiana,	—	—	635.9
	Tennessee,	—	14.8	61.6
	Kentucky,	199.9	83.9	38.8
Territorial Gover.	Alabama,	—	—	67.1
	Mississippi,	—	35.6	87.0
	Illinois,	—	—	349.5
	Missouri,	—	—	—
	Michigan,	—	—	86.8
	Arkansas,	—	—	—
	Columbia,	—	303.8	37.5

On reviewing the rates of increase exhibited in this Table, we cannot fail being struck by their singular diversity. In some the increment is feeble and unimportant, while in others it assumes a form remarkable for its magnitude. Their inequality also clearly proves, that the causes which have contributed to produce them, have not resulted from the operation of regular laws; and that they must have unquestionably arisen from those accidental causes, which a country influenced by immigration must be necessarily subject to. If we contrast, for example, the increments which the states of Vermont, New York, and Kentucky respectively received, in the periods from 1790 to 1800, and from 1810 to 1820, we shall perceive a striking inequality. Vermont, which, in the first of the periods alluded to, received an increment of 80.6 *per cent.*, in the last received only 8.2. New York also, which, from 1790 to 1800, increased its population 72.3 *per cent.*, in the period from 1810 to 1820 increased only at the rate of 32.7; and Kentucky, which, in the decade after the first census, augmented its population nearly 200 *per cent.*, in the last ten years advanced only 38.8 *per cent.* In the State of Ohio also, the changes have been no less remarkable. In the first period it received an increment of 27.1 *per cent.*; but, during the next ten years, this was augmented to 408.7, and in the ten years comprised between 1810 and 1820, it declined to 151.9 *per cent.* These unequal increments are indeed so numerous, that in the whole of the states and ter-

ritories, two only can be found, namely, Massachusets and Connecticut, in which the increments, during the three periods embraced by the Table, present any thing like an uniformity in their rates of increase. It is curious to compare the increments of New York with those of Virginia. In 1790, the latter State possessed a greater population than any other American State; but the large increments received by the population of New York, accelerated its population in a more rapid degree than that of Virginia; so that in 1820, the province of New York possessed the maximum population. Hence, in the short space of thirty years, the population of New York was increased from 340,120 to 1,372,812; being more than quadrupled in that time. Virginia, during the same interval, only changed its population from 747,160 to 1,065,366; so that while the former State increased its inhabitants in the ratio of 8 to 2, the latter only augmented it in the ratio of 3 to 2: a difference, I should apprehend, not to be accounted for from the ordinary laws of human procreation. Pennsylvania increased its population in the same time, in about the ratio of 5 to 2. Louisiana, presents the most remarkable increase in the whole series. The increment in ten years was 635.9 *per cent.*; so that here is an example of a population being more than sextupled in the short space of ten years. The larger class of increments, it will be perceived, form no inconsiderable portion of the Table. In the whole Table there will be found eleven increments below 10 *per cent.*; seventeen increments between 10 and 20 *per cent.*; five between 20 and 30 *per cent.*; nine between 30 and 40; one between 40 and 50; three between 50 and 60; three also between 60 and 70; one between 70 and 80; four between 80 and 90; one between 90 and 100; two between 100 and 200; three between 300 and 400; and three between 400 and 700. Rhode Island, in the period from 1790 to 1800, and Delaware in that from 1810 to 1820, are the only instances of a close approximation of the population to a stationary state.

Having made these few brief observations on the increments which the different States have received, since the first authentic census of the American people in 1790; it may be useful, in

the next place, to examine the increments which the free white males and females, of the different ages, have received in the aggregate of all the States and territories, during the same periods. For this purpose, the following Table has been computed:

	AGES.	MALES. Increase *per cent.*	FEMALES. Increase *per cent.*
First period, from 1790 to 1800.	Under sixteen,	31.8	
	Sixteen and upwards,	33.8	
	All ages,		35.6
Second period, from 1800 to 1810.	Under ten years,	45.0	35.2
	Ten, and under sixteen,	36.1	38.6
	Sixteen, and under twenty-six,	39.3	39.8
	Twenty-six, and under forty-five,	32.3	34.2
	Forty-five and upwards,	38.8	32.8
Third period, from 1810 to 1820	Under ten years,	29.9	30.4
	Ten, and under sixteen,	30.7	31.9
	Sixteen, and under twenty-six,	37.8	39.0
	Twenty-six, and under forty-five,	33.7	35.3
	Forty-five and upwards,	[illegible]	36.3

In the division of this Table, which comprises the period from 1800 to 1810, the male increment attains its maximum, in the class of persons under ten years of age, and its least value in the class of twenty-six, and under forty-five. In the same division, the maximum of female increment occurs in the class of persons of sixteen, and under twenty-six, and accords with the greatest male and female increment of the succeeding division. In this last division also, the minimum increments occur for each sex, in the class of persons under ten years of age. The male and female increments of the class of persons under ten years of age, in the second division, exhibit a remarkable contrast to the corresponding increments of the third division; the former having a difference of nearly 10 *per cent.* in the rates of their increase, while the latter is nearly in a state of equality. The same remark will also apply to the class of forty-five and upwards, in the same divisions: for in the second division, the male increment of this class has an ascendancy over the female increment of the same class of 6 *per cent*; whereas the corresponding increments of the succeeding division approach nearly to a state of equality. The near approximation also of the

four rates of increase belonging to the class of persons of sixteen and under twenty-six, in the second and third divisions, is not unworthy of attention. All the male increments, excepting the first, in the second division of the Table, are less than their corresponding female increments; and in the third division, the female increments in every case exceed their corresponding male increments. These rates of increase exhibit a greater uniformity than we should at first be led to expect.

The increments of the ages contained in the preceding Table were deduced from the aggregate population of all the states and territories, during the several periods indicated in it. In the next place, therefore, we shall proceed to the consideration of the various increments which each age and sex has received in every individual State; and for this purpose the following Table has been computed, to illustrate the period comprised between 1790 and 1800.

	States & Territories.	Free white Males under 16 years.	Free white Males of 16 years and upwards.	Free white Females of all ages.
North. States.	Maine,	62.[illegible]	19.9	58.0
	New Hampshire,	30.8	26.3	30.8
	Massachusetts,	10.2	11.2	10.8
	Rhode Island,	3.2	3.1	2.8
	Connecticut,	5.4	5.5	5.2
	Vermont,	85.7	68.7	84.1
Middle States.	New York,	81.8	70.5	76.0
	New Jersey,	20.1	8.0	11.8
	Pennsylvania,	39.6	37.3	37.9
	Delaware,	4.5	4.8	10.9
	Ohio,	26.6	82.2	31.0
South. States.	Maryland,	7.7	7.5	6.8
	Virginia,	11.4	16.5	17.3
	North Carolina,	16.4	16.4	18.1
	South Carolina,	40.2	33.1	42.6
	Georgia,	101.6	95.8	87.6
	Kentucky,	200.9	181.4	197.1

The irregularity in these increments is very remarkable. In three of the northern states, viz. Maine, New Hampshire, and Vermont; three also of the middle states, viz. New York, New Jersey, and Pennsylvania; and likewise in four of the southern states, namely Maryland, South Carolina, Georgia, and Kentucky,—the free male increments under 16 years of

age exceed the corresponding increments of the class above sixteen. In North Carolina the two increments are precisely the same: and in Connecticut they may be nearly regarded as such. Rhode Island presents the only instance of a decrement. The most remarkable disparity in the increments of the two classes is in the state of Ohio, where the difference amounts to 55.6 *per cent*: a circumstance most probably to be accounted for, from a considerable increase of the second class, by immigration. The greatest difference in any of the other states amounts only to 17 *per cent*. In the northern states, Vermont received the greatest increment, and Rhode Island the least. In the middle states, New York had the largest increase, and Delaware the smallest: and in the southern states, Kentucky experienced the greatest increment, and Maryland the smallest. Kentucky exhibited a [illegible] larger increment than any other state, and Rhode Island a smaller, not only in both classes of males, but also in the classes of females. Connecticut and Maryland present the greatest degree of constancy in these increments, and Ohio the least. It is most remarkable, however, notwithstanding the male and female increments appear so irregular, it seems impossible to trace the existence of [illegible] yet that the sum of the [illegible] the mean of the sum of the [illegible] and the mean of the sum of the males [illegible]—a coincidence most striking and singular.

* [illegible] of his Philosophy of the Human Mind, page 2[illegible], when speaking of the uniformity of the course of nature, has the following remarks. "How accidental soever these circumstances may appear, and how much soever they may be placed, when individually considered, beyond the reach of our calculation, experience shews that they are somehow or other mutually adjusted, so as to produce a certain degree of uniformity in the result; and this uniformity is the more complete, the greater is the number of circumstances combined. What can appear more uncertain than the proportion between the sexes among the children of the same family! and yet how wonderfully is the balance preserved in the case of a numerous society! What more precarious than the duration of life in an individual! and yet, in a long list of persons of the same age, and placed in the same circumstances, the mean duration of life is found to vary within very narrow limits. In an extensive district, too, a considerable degree of regularity may sometimes be traced for a course of years in the proportion of births and deaths to the number of the whole inhabitants. [illegible]

The next table relates to the various rates of increase in the different ages, and in the different states and territories, in the period comprised between the enumerations of 1800 and 1810.

	States and Territories.	Males.					Females.				
		Under 10.	10 and under 16.	16 and under 26	26 and under 45.	45 and upwards.	Under 10.	10 and under 16.	16 and under 26.	26 and under 45.	45 and upwards.
North. States.	Maine,	47.6	50.0	58.2	41.1	59.4	45.5	57.2	60.1	48.1	55.6
	New Hampshire,	11.7	19.9	15.2	16.6	23.4	8.2	21.6	21.2	19.1	25.2
	Massachusets,	8.3	7.6	18.8	15.4	11.6	9.8	7.9	14.5	12.3	12.9
	Rhode Island,	8.0	3.8	23.1	17.0	11.3	10.8	7.2	16.4	10.3	12.8
	Connecticut,	50.4	5.6	10.1	2.2	7.9	0.5	3.9	6.0	4.4	9.0
	Vermont,	29.4	52.3	48.6	25.7	61.6	29.5	52.6	74.4	36.6	62.5
Middle States.	New York,	65.8	66.5	74.1	54.0	69.5	65.4	74.3	76.9	52.1	59.1
	New Jersey,	11.5	19.3	30.2	7.2	26.7	10.5	19.9	24.5	9.1	30.3
	Pennsylvania,	34.1	35.9	36.7	25.0	35.0	32.3	39.2	40.7	31.5	36.9
	Delaware,	16.8	1.0	0.6	17.0	30.0	18.5	2.1	0.0	11.0	20.3
	Ohio,	398.0	396.8	335.5	370.9	502.3	411.2	403.1	417.7	481.6	524.8
South. States.	Maryland,	3.5	2.9	2.0	5.7	8.6	2.4	1.8	2.5	3.9	11.3
	Virginia,	5.8	6.0	5.7	4.6	16.8	3.9	8.9	8.2	23.9	1.5
	North Carolina,	7.8	11.9	9.7	10.4	13.4	10.7	16.1	14.9	10.7	16.6
	South Carolina,	6.0	6.1	17.9	5.9	10.3	8.2	1.9	13.4	10.1	15.8
	Georgia,	41.1	41.1	43.9	31.7	49.9	42.8	42.0	45.6	39.8	60.2
	Tennessee,	131.4	138.7	135.3	138.9	158.3	126.6	131.9	132.2	152.1	143.1
	Kentucky,	74.7	90.8	89.6	67.0	89.9	73.9	91.6	90.4	73.6	90.6
Territ.	Missisippi,	322.1	359.8	458.5	300.5	291.5	321.3	310.6	521.3	287.2	309.1
	Columbia,	178.8	261.9	214.8	278.3	291.8	278.8	280.8	245.1	266.6	340.2

The district of Maine, which, in the table formed to illustrate the period from 1790 to 1800, was found to have all the increments of its different ages inferior to those of Vermont, will be found, in the preceding table, to have some of its increments superior, and some inferior, to the corresponding rates of increase in the latter state. In the male and female increments under ten, a remarkable superiority will be perceived to exist in the district of Maine; and so also in the male class of sixteen and

Necker informs us, that the number of births is in proportion to that of the inhabitants as one to twenty-three and twenty-four, in the districts that are not favoured by nature, nor by moral circumstances: this proportion is as one to twenty-five, twenty five and a half, and twenty-six, in the greatest part of France; in cities, as one to twenty-seven, twenty-eight, twenty-nine, and even thirty, according to their extent and trade. Such proportions, Necker observes, can only be remarked in districts where there are no settlers nor emigrants; *but even the differences arising from these, and many other causes, acquire a kind of uniformity when collectively considered, and in the immense extent of so great a kingdom.*"

under twenty-six, and in the male and female classes of twenty-six and under forty-five. In Vermont, a very large female increment will be found in the class of sixteen and under twenty-six; and the male and female increments under ten, will also be found approaching exceedingly near to equality. A similar approximation to equality will likewise be found to belong to the increments of both sexes, in the classes from ten to sixteen, and forty-five and upwards. The large increment which Ohio received in the former period in the class of free males above sixteen, was succeeded by a still larger rate of increase in the period extending from 1800 to 1810; the least increment it received during that time being 335.5 *per cent.*, and the greatest 524.8. New York, therefore, which in the preceding period stood decidedly above Ohio in the proportional magnitude of its increments, in this last period yielded to the latter state; and which also presents increments of a larger kind than any other province during the same period of time. In the southern states also, Tennessee has gained a like ascendancy over Kentucky; and of the other territories of Missisippi and Columbia, the latter is distinguished by the largest increase.

In several of the States, the increments of the different ages present instances of equality not unworthy of attention. In Vermont, New-York, Kentucky, and Missisippi, the rates of increase of the males and females under ten, are very nearly the same; the difference not amounting in any case to a single unit. In New Jersey, also, the male and female increments of the class of ten, and under sixteen, present an approximation to equality. In North Carolina, the increments of the first and fourth classes of females are the same, and the second and fifth very nearly equal. In South Carolina, the male increments of the first, second, and fourth classes, are nearly the same. In Georgia, there is an absolute equality of the male increments in the first and second classes; and a near approach to the same state, in the corresponding classes of females. The increment in the last class of females, has a remarkable ascendancy over the corresponding class of males. In Tennessee, the male increments of the second and fourth classes are nearly equal; as well as the female increments in the second and third classes, and the first class of males. Kentucky presents a remarkable instance of a

close approach to equality, between the male and female increments, in four classes out of five, into which the ages are divided. The single class, indeed, where this degree of equality does not exist, namely, in that of twenty-six and under forty-five, the difference is not very considerable. The causes, therefore, that have operated in Kentucky to increase its population, have acted almost uniformly on all ages. In Delaware, the rates of increase are very singular. Both the male and female classes under ten, and also the fourth and fifth classes of each sex, present examples of moderate increments; but the third class of females we find stationary, the corresponding class of males with only an increment of $\frac{7}{10}$ths *per cent.*; and in the second class of males and females, increments almost equally feeble. The first class of males in Connecticut, and the last class of females in Virginia, present the only instances of decrements.

The maximum increments of the different ages for both sexes, appear to exist in some of the States, in the class of persons of sixteen and under twenty-six; and in other States, in the class of forty-five and upwards; the females in Virginia, Tennessee and Kentucky, being the only exceptions in this curious law. In the following columns, the States and Territories are arranged, according to the ages in which the maximum increments are found.

States and Territories in which the Maximum Increments of Males are found.		States and Territories in which the Maximum Increments of Females are found.	
16 and under 26.	45 and upwards.	16 and under 26.	45 and upwards.
Massachusets.	Maine.	Maine.	New Hampshire.
Rhode Island.	New Hampshire.	Massachusets.	Connecticut.
Connecticut.	Vermont.	Rhode Island.	New Jersey.
New-York.	Delaware.	Vermont.	Delaware.
New-Jersey.	Maryland.	New-York.	Maryland.
Pennsylvania.	Virginia.	Pennsylvania.	North Carolina.
South Carolina.	North Carolina.	Mississippi.	South Carolina.
Mississippi.	Georgia.		Georgia.
	Tennessee.		Ohio.
	Kentucky.		Columbia.
	Ohio.		
	Columbia.		

Although the maximum increments which both sexes have received in the period from 1800 to 1810, present a singular degree of uniformity, and appear to be the result of some

law, which operates in by far the greater part of the States and territories, in such a way as to cause the maximum increments to appear either in the class of persons of sixteen and under twenty-six, or in that of forty-five and upwards, still no law appears to exist relative to the minimum increments; these being found for both sexes in every variety of age. The remark, however, relating to the maximum increments, is not unworthy of notice; and as Lord Bacon has observed in his admirable Essays, 'I 'would not have it given over, but waited upon a little.'

The following Table has been deduced from a comparison of the Population Returns for 1810 and 1820, and, taken in conjunction with the preceding Tables, will lead to some interesting results.

	States and Territories.	Males.					Females.				
		Under 10.	10 and under 16.	16 and under 26.	26 and under 45.	45 and upwards.	Under 10.	10 and under 16.	16 and under 26.	26 and under 45.	45 and upwards.
North. States.	Maine,	19.2	14.7	39.8	25.6	44.3	18.9	34.5	44.8	31.6	48.0
	New Hampshire.	3.4	10.3	20.4	11.8	27.3	7.1	9.5	19.3	17.6	31.1
	Massachusets.	2.9	10.3	9.9	18.7	10.6	3.6	15.7	13.9	17.2	15.7
	Rhode Island,	7.4	5.5	1.8	12.6	8.3	3.1	7.1	11.8	13.6	12.3
	Connecticut.	2.6	0.9	8.2	8.2	6.5	1.8	4.8	8.9	10,6	10.1
	Vermont,	6.6	1.9	22.7	6.0	24.0	3.7	7.1	17.8	13.9	32.9
Middle States.	New-York,	31.2	41.1	54.8	16.1	50.5	37.1	48.1	55.6	51.4	54.9
	New-Jersey,	11.2	5.6	16.1	14.1	15.8	10.7	9.7	20.9	15.6	19.4
	Pennsylvania,	26.6	23.1	38.2	30.9	23.8	26.5	28.7	33.5	33.2	30.3
	Delaware,	6.2	0.1	7.1	1.6	13.1	1.1	1.4	0.6	0.2	14.7
	Ohio,	186.5	153.1	182.4	129.5	161.3	139.9	161.5	166.8	151.1	171.8
	Indiana,	501.8	495.9	531.7	507.6	528.1	507.7	474.7	511.9	538.8	539.0
Southern States.	Maryland,	7.5	2.5	16.4	10.5	11.8	9.2	9.8	11.3	15.[illegible]	[illegible].7
	Virginia,	6.3	6.6	11.1	10.1	8.3	8.6	8.1	13.7	9.4	9.8
	North Carolina,	10.9	8.5	14.1	5.2	20.1	8.5	10.1	11.4	12.2	23.0
	South Carolina,	5.1	3.7	11.6	5.3	20.2	3.9	10.1	12.5	7.6	18.4
	Georgia,	26.6	23.4	38.3	24.1	16.1	26.2	32.9	38.5	23.9	44.9
	Louisiana,	243.7	250.2	157.8	115.1	398.7	241.3	353.5	368.8	315.9	451.9
	Tennessee,	52.3	65.9	59.2	37.0	76.2	51.7	70.1	58.9	56.8	84.2
	Kentucky,	27.5	34.3	38.8	29.2	43.3	27.7	36.4	42.0	26.9	54.3
Territories.	Alabama,	192,5	152,1	215.1	76.4	62.0	193.6	143.0	178.1	118.9	93.1
	Mississippi,	92.2	96.5	69.4	61.7	100.7	79.8	105.7	73.3	77.2	136.4
	Illinois,	365.8	37.3	388.6	329.8	375.0	373.4	408.0	359.8	366.0	395.3
	Michigan,	52.5	65.0	128.8	117.7	79.1	76.5	58.1	88.0	91.3	104.6
	Columbia	32.2	32.1	42.8	37.3	19.1	30.8	37.6	52.3	50.8	62.4

PLYMOUTH,
October 29 1822

(To be continued.)

Art. X.—*Account of the Great Cave of Gailenreuth in Franconia, and of the Cave of Kirkdale in Yorkshire.* With a Plate.

THE recent discovery of the cave of Kirkdale, near Kirby Moorside, in Yorkshire, containing an assemblage of the bones of elephants, rhinoceroses, bears, tigers, and hyænas, has excited a great degree of interest among all classes, and given rise to very curious geological speculations, respecting the period when these fossil remains were deposited, and the means by which they have been conveyed into their present subterraneous habitation.

The details of comparative anatomy which these speculations involve, are too extensive for the pages of a Journal, and the geological conclusions which have been founded on them, and which Professor Buckland has rendered so very interesting, belong to another department of this work. Our intention at present is to give an account of these caves, as objects of physical geography, and as a continuation of those interesting descriptions of the Caverns of the Guacharo, the Great Cave of Indiana, the Ice Cave of Fondeurle, and those in the Jura and the Alps, which have already been printed in this Journal.

Description of the Cave at Gailenreuth.

The great Cave of Gailenreuth, near Bamberg, in Franconia, is represented in section in Plate II. Fig. 1., as drawn on the spot by Professor Buckland, in 1816.

The external mouth of the cavern is in the steep side of a hill, and communicates by the entrance passage A, which varies in height from five to eight feet, and has a few bones irregularly scattered along the floor. This passage expands internally into the first large chamber B, which has stalactites of all sizes hanging from its roof, and numerous bones of bears strewed upon its floor. The second chamber C, on a lower level, is separated from the first B, by a perpendicular precipice. The bones are scattered more abundantly over its floor than in B, and it has probably other branches communicating with it laterally. A large aperture D, descends obliquely downwards from C, and contains cart-loads of loose bones. The mass E is a compact

breccia, composed chiefly of bones cemented by stalagmites. The chamber C is connected with the vertical fissure G, by a long and low passage F; the length of which is not represented in the Plate for want of room. It is so extremely low, that the traveller is obliged to traverse it by crawling on his hands and knees. The vertical fissure G, which has very considerable depth and a width of only *three* feet, can be descended only by supporting the hands and feet on niches cut in the opposite sides of the fissure. The cave ends with an oven-shaped cavity H, which has been excavated artificially by the extraction of bones and skulls from the osseous breccia.

To this general description of the Gailenreuth Cave, as seen by Professor Buckland, it may be proper to add the more minute account of it given by M. Deluc. Accompanied by the inspector of the caverns, who took with him a man who carried a ladder and some lights, the party first ascended the Wiesent, about half a league on the Muggendorf side, and then crossed it at the Mills of Bamfort. The precipitous sides of the valley had every where the appearance of ruins, and they advanced towards each other at the points where the mills are placed. They here crossed over to the left bank, and arrived at the cavern after an ascent of nearly half an hour. The entrance, which is at first narrow, is under a large rock, but the passage soon opens into a wide space, divided into several cells, apparently produced in part by the decomposition of the limestone, which is here mixed with a great deal of sand. Beyond this every thing is encrusted with stalactites, below, above, and on the sides.

Near a crevice opening at the foot of a mass detached from the superior strata, they partly descended by a ladder, about twenty feet long, into one of the lower chambers (viz. C in the Plate), where the bones had been accumulated in the greatest abundance. This crevice had once been nearly obstructed by stalactites, which were cut away in order to widen the passage, and there are marks of some fissures of this kind having been completely closed up in the same manner. The inspector informed Deluc, that when this cave was first entered, the bones were not all covered with stalactites, so that it was then easy to obtain well preserved bones, among which were entire heads, and other bones characteristic of the species of animal. The

increase of the stalactites, however, since that time, has rendered it very difficult to take out any bones, without breaking them. These bones belong to the white bear of the North (*Ursus spelæus*), though they differ, in some respects, from those of the same animal now living. Another chamber was discovered here at a still lower level, by widening an aperture, which the stalactites had nearly closed. In order to reach this cave, the party was obliged to creep backwards about twenty feet (along the passage at F in the Plate), beneath a large mass of strata. This brought them to another space covered with stalactites, where the search for bones was then carrying on. It was in spaces of this kind where the stalactites, when dug through, were found, *in many places, to have been formed on sea sand* *

Description of the Cave at Kirkdale in Yorkshire.

The Cave of Kirkdale, situated at the lower extremity of the Dale of Rical Beck, is perforated in a limestone rock, referable to the Oolite formation, called the Oxford Oolite and Coral Rag. About 30 feet of the outer extremity of the cave have now been removed, and its present entrance is a hole in the perpendicular face of the quarry, less than 5 feet square, which a person enters upon his hands and knees. The cave expands and contracts itself irregularly from 2 to 7 feet in breadth and height, diminishing, however, as it proceeds. It is about 15 or 20 feet below the superincumbent field, and its principal direction is E.S.E. It has several zig-zags to the right and left; and its greatest length is from 150 to 200 feet. It branches into several lateral ramifications, some of which have not yet been explored. There are only two or three places where it is possible to stand upright, and these occur where the cavern is intersected with fissures.

The first thing that is observed on entering the cavern (of which a section is given in Fig. 2. Plate II.), is a sediment of argillaceous and slightly micaceous mud A, covering the whole of its bottom to the average depth of about a foot, and concealing the actual floor. Upon advancing some way into the cave, the roof

* See the *Phil. Trans.* 1822, p. 171., and Deluc's *Geological Travels*, in 1798. [illegible] p. 191.

and sides are partially studded and cased over with a coating of stalactite, which descends to the surface of the mud, as at CC, and forms over it a plate or crust, spreading horizontally over its surface like ice over a surface of water. The thickness and quantity of this crust varied with that on the roof and sides, in some places covering the mud entirely, when the stalactite on the sides was most abundant, and in other places being totally wanting, both in the roof and the surface of the mud. A great part of this crust had been destroyed in digging up the mud to extract the bones; but Professor Buckland saw several places where the stalactitic crust was very thick, and formed a continuous bridge across the mud. In some cases insulated stalagmites, like that shewn at D, have been formed on the surface of the sediments, by drops from the roof, but they are commonly not larger than a cow's pap, the name by which the workmen distinguish them

The bones have been found enclosed in the stalagmites, such as B, formed before the introduction of the mud, but principally in the lower part of the sediment. A few perfect bones have been obtained, but most of them are broken into small angular fragments and chips, lying separately in the mud, whilst others are wholly or partially invested with stalactite. The action of this mud in preserving the bones from decomposition is very remarkable, and Professor Buckland found that almost the whole of their gelatine was preserved. The following Table will shew the nature of the bones which have been discovered, and the animals to which they have belonged.

Hyæna.	Forty fragments of jaw-bones; several hundred canine teeth, which must have belonged to more than 100 individuals.
Tiger,	Two large canine teeth, 4 inches long, and one under tooth.
Bear,	One tusk, like that of the Ursus spelæus of the German caves.
Wolf,	Many teeth.
Fox,	Many teeth,
Weazel,	A few jaws and teeth.
Unknown animal, of the size of the wolf,	Several teeth.

Elephant,	Two teeth.
Rhinoceros,	Forty or fifty teeth.
Hippopotamus,	Six molar teeth, and fragments of its canine and incisor teeth.
Horse,	Two or three teeth; coronary bone.
Ox, (two species),	Astragalus, phalangal bone, and several teeth.
Three species of deer,	Several teeth; remains of horns.
Rabbit,	A few teeth and bones.
Water rat,	A great number of teeth and bones.
Mouse,	A few teeth and bones.
Raven,	Right ulna.
Pigeon,	Left ulna.
Lark,	Right ulna.
A small species of duck,	Right coracoid process of the scapula.

Upon first removing the mud, the bottom of the cave was strewed all over like a dog-kennel, from end to end, with hundreds of teeth and bones, or rather broken and splintered fragments of the bones of all the animals above enumerated. They were found most abundantly near its mouth; those of the larger animals, such as the elephant, rhinoceros, &c. occurring as extensively as all the rest, even in the inmost and smallest recesses. With the exception of the hard and solid bones, scarcely a single bone has escaped fracture; and in some of them marks may be traced, which, on applying one to the other, appear exactly to fit the form of the canine teeth of the hyænas that occur in the cave.

From this comminuted and gnawed condition of the bones, Professor Buckland concludes that the cave at Kirkdale had been inhabited during a long succession of years as a den, by hyænas, who had dragged into its recesses the other animal bodies whose remains are found mixed with their own. This conjecture received a very interesting confirmation from the discovery made by Professor Buckland, of many small balls of the solid calcareous excrement of an animal that had fed on bones. This substance was at first sight recognised by the keeper of the menagerie at Exeter Change, as resembling, both in form and appearance, the fæces of the Cape hyæna which was greedy of bones beyond all other beasts under his care. As the bones of the hyænas are as much broken to pieces as those of the other animals, Professor Buckland likewise infers, that the car-

cases even of the hyænas themselves were eaten up by their survivors.

To the probability of these inferences, Professor Buckland has added very greatly, by an inquiry into the habits of modern hyænas, the largest of which is one-third less than the fossil hyæna. It appears, therefore, extremely probable, that the animals had been dragged into the cave for food by the hyænas, who caught their prey in the immediate vicinity of their den; and as they could not have carried it home from any very great distance, it follows that the animals upon whom they fed lived and died not far from the spot where their remains are now found *.

Considering these animals as natives of this country, Professor Buckland regards the accumulation of their bones as a long process, going on during a succession of years; and he supposes that the accumulation was considerably advanced before the introduction of the sediment in which they are imbedded, and by which they have been so well preserved. This, indeed, seems scarcely to admit of a doubt, as the bones which had been long uncovered at the bottom of the den, have undergone a decay proportional to the time of their exposure, while others that have lain only a short time before the introduction of the diluvian sediment, have been preserved by its means almost from incipient decomposition.

From an examination of the present condition of the bones, the mud, and the stalactite, Professor Buckland draws the following inferences respecting the operations that have been going on in the cavern.

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* Professor Buckland has stated other two hypotheses: 1st, That the animals may have entered the cave spontaneously to die, or fled into it as a refuge from some general convulsion; and, 2dly, That their carcases may either have been drifted in entire by the waters of ~ flood, or the bones alone drifted in after their separation from the flesh. Both these opinions are, however, excluded in a great measure by the small size of the cave, which could not have admitted such animals as the elephant and rhinoceros. Had the bones been drifted in singly, they would have been mixed with gravel, and at least slightly rolled on their passage; and it would still be unexplained why they were split and broken in pieces, and why there is such a disproportion between the numbers of the teeth and the bones.

1. There seems to have been *a period* when the cavern was not inhabited by the hyænas. This period appears to have been very short, from the small quantity of stalagmite now found on the actual floor of the cavern.

2. During the *second period* the hyænas inhabited the cavern, and the stalactite and stalagmite were still forming. This formation would be much interrupted by the constant passage of the hyænas, who would knock off the stalactites from the roof and sides of the cave; and accordingly, in some specimens of the breccia, Professor Buckland found fragments of the stalactite mixed with the bones.

3. The *third period*, Professor Buckland considers to be "that at which the mud was introduced, and the animals extirpated, viz. The period of the deluge." He shews, that this mud could not have been introduced by land-floods, often repeated; and he considers the vehicle of the mud to have been the turbid waters of the same inundation that produced the diluvial gravel of the surrounding country.

4. The *fourth period* is that during which the stalagmite was formed, which is deposited over the upper surface of the mud. During this last period, no creature appears to have entered the cave, with the exception possibly of mice, weazels, rabbits and foxes, until its opening last year; and no process whatever seems to have been going on, excepting the formation of stalactitic infiltration.

From the facts now mentioned, Professor Buckland had conjectured that other caverns, similar to that at Kirkdale, would be found. This conjecture has been confirmed, by the discovery of another cave, in a quarry close to the town of Kirby Moorside, on the property of C. Duncombe, Esq. who secured it from injury, till it should be examined by some persons properly qualified. It was accordingly opened in the autumn of 1822, and was found to contain chambers lined with stalactite, and having on its bottom mud, and bones imbedded in it. We have not learned that any facts of importance have been added to those given in the very interesting and able paper of Professor Buckland.

Art. XI.—*Some Experiments on the Changes which take place in the Fixed Principles of the Egg during Incubation.* By William Prout, M. D. F. R. S*.

We place great confidence in every thing that comes from the pen of the author of the interesting memoir of which we are now to give an account. Dr Prout's great accuracy, indefatigable perseverance, and sound judgment, give to all his investigations the stamp of unalloyed excellence. The present memoir contains a series of experiments on a very curious and important subject; and although, as Dr Prout remarks, "the experiments are much less perfect than he could wish," still they add greatly to our present knowledge, and give room for interesting physiological views. In the year 1816, Dr Prout commenced a series of experiments on the egg during incubation, with the view of ascertaining the nature of the changes which take place during that process. This inquiry was chiefly limited to the earthy and saline matters; but his attention was particularly directed to the source whence the earthy matter of the skeleton of the chick was derived.

With these views, the egg was analysed in its recent and unaltered state, and at the end of the first, second, and third weeks of incubation. His experiments were chiefly confined to the eggs of the domestic fowl, but were likewise extended to those of the duck and turkey. This investigation, Dr Prout informs us, was renewed, and the following statement contains the results of his various experiments.

Preliminary Experiments on the Egg in its recent and unaltered State.

The specific gravity of new laid eggs has been found to vary from 1.08 to 1.09. When kept for some time, eggs, as is well known, rapidly lose weight, and at length become so light as to swim in water. This diminution of specific gravity is produced by the substitution of air for a portion of the water which escapes. The following table shews the gradual loss of weight of an egg, during a period of two years:

* Abridged from Dr Prout's Memoir in the Philosophical Transactions, 1822. Part II.

	Grains.	Loss per day.		Grains.	Loss per day.
May 19. 1820,	907.5		May 5. 1821.	648.7	.59
—— 20. ——	906.5	1.00	—— 6. ——	647.8	.90
—— 24. ——	901.3	1.30	Dec. 5. ——	488.2	.75
—— 31. ——	894.2	1.01	—— 7. ——	486.6	.80
June 8. ——	886.6	.95	Mar. 21. 1822.	413.5	.70
—— 17. ——	879.3	.81	April 25. ——	384.6	.82
—— 27. ——	870.7	.86	—— 26. ——	383.7	.90
July 19. ——	848.5	1.01	May 17. ——	365.2	.84
Aug. 7. ——	829 6	.99	—— 18. ——	364.3	.90
—— 26. ——	810 8	.99	—— 19. ——	363.2	.10
Sept. 30. ——	778.5	.92			
			Total loss,	544.3	.744 Mean.

Hence we learn, that a moderately sized egg loses, at an average, about .75 gr. in twenty-four hours, and this uniformly during a very long period. The loss appears to be somewhat greater in summer than in winter, owing, doubtless, to the difference in temperature, which, in the above instance, varied from 40° to 70°. The whole of the contents of this egg were found collected at the smaller extremity in a solid state, but, on being put into water, they absorbed a large quantity of it, and assumed an appearance not much unlike that of a recent egg, the smell being also perfectly fresh.

The relative weights of the shell, albumen, and yolk of different eggs are very different. With the view of investigating this subject, and of obtaining an average, the following experiments were made. The eggs were boiled hard in distilled water, and the different parts weighed immediately in their *moist* state:

Shell and Membrane.	Albumen.	Yolk.	Total.
Grains.	Grains.	Grains.	Grains.
80	394.3	289.	763.3
108	593	273.5	974.5
107.3	575.8	236.2	919.3
71.5	516.5	215	803
103	303.7	269.3	876
107	515.3	273.4	895.7
93.2	605.5	252.4	951.1
92.7	515.7	257	865.4
96.8	510.6	210.8	818.2
77.6	567.4	241.5	886.5
Mean, 93.7	529.8	251.8	875.3

If each of these eggs be supposed to weigh 1000 grs., the weights of the constituent principles of each, when reduced to this common standard, will be as follows:

Shell and Membrane.	Albumen.	Yolk.
Grains.	Grains.	Grains.
104.8	516.6	378.6
110.8	608.5	280.7
116.7	626.3	257.0
89.0	643.2	267.8
117.6	575.0	307.1
119.5	575.3	305.2
98.0	636.6	265.4
107.1	596.0	296.9
118.3	624.0	257.7
87.5	640.0	272.5
Average, 106.9	604.2	288.9

If the recent egg, then, be supposed to weigh 1000 parts, the relative proportions of the shell, albumen, and yolk, will be as 106.9, 604.2, and 288.9; and, for the sake of easier comparison in all the subsequent experiments, the numbers are reduced to this standard.

When an egg is boiled in water, it loses weight, especially if it be removed from the water when boiling, and be permitted to cool in the air *; the water also is found to contain a portion of the saline contents of the egg. The loss of weight from boiling is by no means constant, but has been found to vary from 20 to 30 grs., on the supposition that the original weight of the eggs employed were 1000 grs. On the same supposition also, the quantity of saline matter obtained by evaporating to dryness the distilled water in which an egg has been boiled, amounts, at an average, to about 32 gr. This saline residuum is strongly alkaline, and yields traces of animal matter, sulphuric acid, phosphoric acid, chlorine, an alkali, lime, and magnesia, and carbonates of lime and magnesia; in short, of almost every principle existing in the egg. The carbonate of lime, however, is generally the most abundant substance, and is obtained by evaporation, in the form of a fine powder.

* When permitted to cool in water, it sometimes gains a little in weight, owing to the absorption of water.

The shells of eggs have been analysed by *Vauquelin* and *Merat Guillot*, but these chemists seem to have over-rated the quantity of animal matter, and of phosphate of lime, contained in them. When shells, which had been dried *in vacuo* at 212°, were dissolved in dilute muriatic acid, the quantity of animal matter obtained was only about 2 *per cent.*, while the quantity of phosphates of lime and of magnesia never amounted to quite 1 *per cent.*; the rest was carbonate of lime, mixed with a little carbonate of magnesia When burnt, egg-shells, as Vauquelin has observed, yield traces of sulphur and iron.

The *membrana putaminis*, on the supposition that the original weight of the egg is 1000 grs., weighs, when dried *in vacuo* at 212°, about 2.35 grains; and, on being burnt, yields traces of phosphate of lime.

Saline Contents of the recent Egg.

It may here be premised generally, that all the results of the following analyses were obtained by combustion; and that the observations are to be understood as applicable to the whole of the experiments subsequently related in this inquiry.

The *albumen* burns with difficulty, unless care be taken to remove the saline matter by frequent washings; but if this point be attended to, the whole of the carbonaceous matter may be burnt off even in a covered crucible. In the subsequent experiments, the saline and earthy matters were removed from the crucible after combustion by distilled water; a little ammonia was then added, and the whole permitted to remain at rest for twenty-four hours. The clear solution containing the alkaline salts was now carefully poured off, and the insoluble residuum, consisting of the phosphate of lime and triple phosphate of magnesia and ammonia, after being washed with distilled water, was dried and weighed. The alkaline solution, together with the washings of the earthy phosphates, were then evaporated to dryness, and exposed to a low red heat; and the weight of the saline residuum being accurately noticed, the whole was again dissolved in distilled water. A few drops of nitric acid being now added to neutralize the excess of alkali present, nitrate of barytes was dropped into the solution as long as any precipitate fell. The precipitate was obtained by de-

canting off the solution as before, and, after being well washed, its weight ascertained . from this the quantity of sulphuric acid present was determined by calculation. To the solution thus freed from sulphuric acid, nitrate of barytes, and afterwards ammonia, were added. The phosphate of barytes thus obtained was collected, washed and weighed as before, and the quantity of phosphoric acid present obtained by calculation Nitric acid was again added in slight excess to the original solution, and nitrate of silver dropped into it as long as any precipitate fell : from the chloride of silver obtained, the quantity of chlorine present was estimated. Lastly, The weights of the sulphuric and phosphoric acids and chlorine were added together, and their amount subtracted from the weight of the alkaline residuum formerly obtained by evaporation, the remainder, of course, indicated the quantity of potash and soda, and carbonates of potash and soda present. Finally, the proportion of the earthy phosphates to one another was determined, and the quantities of the bases and acid obtained by calculation.

The *yolk* of the egg is exceedingly difficult of combustion; and, indeed, without proper precautions, cannot be burnt at all, on account of the large quantity of phosphorus contained in it, which, by undergoing a partial combustion, forms a glassy coating, that effectually excludes the contact of the air from the coal, and prevents its farther combustion. After a variety of attempts, the following were the two methods employed. The yolk of an egg which had been boiled hard, and dried by exposure to the air, was rubbed in a mortar with a quantity of bicarbonate of potash. The mixture was then introduced into a platina crucible, and exposed to a strong red heat, till the flame had ceased to escape from a small hole in the lid. The crucible being now removed from the fire, its contents, when cold, were again pulverised in a mortar with nitre. This mixture was then introduced, a little at a time, into the covered crucible, till the whole was burnt. To the residuum distilled water was added, which of course took up every thing but the earthy phosphates, which were separated and weighed, while the alkaline solution, like that before mentioned, obtained from the albumen, was submitted to the action of the appropriate reagents, and thus the quantities of the different acids present

ascertained. In this manner every thing was determined, except the proportion of alkaline matter present; and to ascertain this, other experiments with different yolks were made, in which lime and nitrate of lime were substituted for the bicarbonate and nitrate of potash.

Berzelius has remarked, that the sulphuric acid obtained from albumen is probably a product of combustion, and exists in it naturally as sulphur. The same also appears to be the case with the phosphoric acid, especially that obtained from the yolk. The chlorine seems to exist originally in union with sodium, forming common salt. As to the earthy principles, Berzelius is of opinion that their metallic bases are probably to be considered as constituent principles of the primary animal compounds. These circumstances have induced me to state the quantities of the acids obtained separately from the bases.

The relative proportions of the saline principles of different eggs vary in some instances considerably. The three following are selected from a variety of other analyses as examples; the weight of each egg being reduced, for the sake of comparison, to 1000 grains.

No. I.

	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. & Carb. of do.
	Gr.	Gr.	Gr.	Gr.	Gr.
Albumen,	.29	.45	.94	2.92	.30
Yolk, -	.21	3.56	.39	.50	.68
Total, -	.50	4.01	1.33	3.42	.98

No. II.

	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. & Carb. of do.
	Gr.	Gr.	Gr.	Gr.	Gr.
Albumen,	.15	.46	.93	2.93	.25
Yolk, -	.06	3.50	.28	.27	.61
Total, -	.21	3.96	1.21	3.20	.86

No. III.

	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. & Carb. of do.
	Gr.	Gr.	Gr.	Gr.	Gr.
Albumen,	.18	.48	.87	2.72	.32
Yolk, -	.19	4.00	.44	.51	.67
Total, -	.37	4.48	1.31	3.23	.99

The analysis of the yolk of the recent egg shews it to consist of the following principles in the proportion mentioned .

	Grs.
Water, - -	170.2
Albumen, - -	55.3
Yellow Oil, - -	91.0
	316.5

Experiments on the Egg at the end of the first week of Incubation.

On the supposition that the egg originally weighed 1000 grs., it has generally lost about 50, at the end of the first week; and the weights of the constituent principles of two eggs in their moist state, were as follows:

	No. I.	No. II.
	Grains.	Grains.
Unchanged albumen, - - - - -	232.8	247.1
Modified albumen, - - - - -	179.8	
Liq. amnii, membranes, blood-vessels, &c.	97.0	275.2
Animal, - - - - - - -	22.0	
Yolk, - - - - - - - -	301.3	324.5
Shell and loss. - - - - -	167.1	153.2
	1000.0	1000.0

As the present inquiry seems to be in some respects illustrative of the subject, I shall offer a few remarks on the general phenomena presented by the different constituent principles of the egg at those periods at which it has been submitted to examination.

It has been observed, that soon after incubation has commenced, the yolk becomes more fluid than usual, and that as the liquor amnii increases, that portion of the albumen occupying the upper and larger end of the egg begins to assume a peculiar appearance. In the present experiment, in which the egg was previously boiled, the liquor amnii and portion of albumen in question, about the eighth day, exhibited something of the appearance of curds and whey. Nor was the analogy confined to appearance only, for the curdy looking matter, which was of a yellow colour, and which I have termed *modified albumen*, resembled the coagulable part of milk in its properties, in so far as to contain intermixed with it an oily or butyra-

ceous principle. A portion of this oily principle was found to be soluble in alcohol, the solution having a bright yellow colour; and, in short, to possess all the properties of the yellow oil existing in the yolk. The yolk at this period has become more fluid, paler, and, as is rendered probable by the above table, although the fact be denied by Haller, heavier. These appearances of the albumen and yolk have induced with some a belief that an interchange of principles takes place between them, while others seem to have mistaken the yellow modified albumen for the yolk itself. That an intermixture of principles has really taken place, there can be little doubt; yet the two are not indiscriminately mixed; for when the egg has been previously boiled, the yolk, though softer than natural, is nevertheless rendered of a firmer consistence than the modified albumen, and can thus be readily separated from it; there being besides a distinct line of demarcation betwixt them, arising, apparently, from the proper membrane of the yolk. Another argument in favour of the opinion in question, is derived from the following analyses of these constituent principles of the egg, from which it will be found that the quantity of saline matter is diminished in the albumen, and increased in the yolk. It is a singular and striking fact, however, that although the oily matter has made its way to the albumen, very little of the phosphorus, which exists in such large quantities in the yolk, has been removed from it.

	No. I.					No. II.				
	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. & Carb. of do	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Potash, Magne. & Carb. of do.
	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.
Unchanged albumen, -	.13	.27	.19	1.03	.18	.18	.18	.24	1.50	.12
Modified albumen, liquor amnii, animal, membranes, &c.	.08	38	.45	1.17	.12	.10	.25	.30	.70	.12
Yolk, -	.09	1.03	.60	.80	68	.08	1.00	.56	.75	.67
	.30	1.68	1.24	3.00	.98	.36	1.43	1.10	2.95	.91

The following are the results of an analysis made two days later, or on the tenth day of incubation:

	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, and Carbonate of ditto.	Lime, Magnesia, and Carbonate of ditto.
	Grain.	Grains.	Grain.	Grains.	Grain.
Unchanged albumen,	.27	.14	.24	1.13	.12
Modified albumen, liquor amnii, animal, membrane, &c.	.08	.65	.68	1.36	.27
Yolk,	.05	3.35	.30	.62	.66
	.40	4.14	1.22	3.11	1.05

At this period the proportion of phosphorus is somewhat diminished in the yolk, and increased in the animal and its appendages. The chlorine and alkaline principles seem also to have diminished in the yolk, and to have increased a little in the albuminous portion.

Experiments on the Egg at the end of the second week.

At the end of the second week of incubation, an egg has lost upon an average about 130 grs., on the supposition that its original weight was 1000 grs., and the weight of the constituent principles of two eggs were as follows:

	Grains.	Grains.
Unchanged albumen,	175.5	208.0
Liquor amnii, membranes, &c.	273.5	218.2
Animal,	70.0	89.1
Yolk,	250.7	248.0
Shell and loss,	230.3	236.7
	1000.0	1000.0

At this period the animal has attained a considerable size, while the albumen has become diminished in a corresponding degree. The albumen has also acquired a very firm consistence, especially when coagulated by heat. The liquor amnii has become more fluid, and the *modified* albumen formerly mentioned, has very much diminished in quantity, or disappeared. The yolk, which at the end of the first week seemed to have

increased in bulk and fluidity, has now apparently acquired its original size and consistence. The following are the results of the analyses of the constituent principles of the above two eggs:

	No. I.					No. II.				
	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. & Carb. of do.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. & Carb. of do.
	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.
Unchanged albumen,	.07	.22	.09	.73	.10	.11	.19	.23	.97	.09
Liquor amnii, membranes, &c.	.06	.21	.71	.96	.08	.03	.20	.70	1.07	.08
Animal,	.06	.23	.09	.46	.27	.06	.24	.07	.44	.28
Yolk,	.30	3.34	.16	.68	.69	.20	3.30	.10	.42	.70
	.49	4.00	1.05	2.83	1.14	.40	3.93	1.10	2.90	1.15

An egg analysed two days later, or on the seventeenth day of incubation, gave the following results:

	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, and Carbonate of ditto.	Lime, Magnesia, and Carbonate of ditto.
	Grains.	Grains.	Grains.	Grains.	Grains.
Liquor amnii, membranes, animal, &c.	.34	1.70	.68	2.40	1.10
Yolk,	.10	2.50	.30	.56	.75
	.44	4.20	.98	2.96	1.85

At this period ossification has made some progress, the yolk has parted with some of its phosphorus, which appears in the other principles of the egg, and the quantity of earthy matter has increased.

Experiments on the egg at the end of the third week, or at the full period of incubation.

At this period an egg has lost upon an average about 160 grains, taking the original weight to be 1000; and the weight of the constituent principles of two eggs in their moist state, and without boiling, were as follows:

	Grains.	Grains.
Residuum of albumen, membranes, &c.	29.5	38.1
Animal, - - - - -	555.1	553.6
Yolk, - - - -	167.7	151.3
Shell and loss, - - -	247.7	257.0
	1000.0	1000.0

At this period, all the important changes of incubation are completed. The albumen has now disappeared, or is reduced to a few dried membranes and an earthy residuum. The yolk is considerably reduced in size, and is taken into the abdomen of the chick, while the animal has attained a weight nearly corresponding to the original weight of the albumen, added to that lost by the yolk, *minus* the total loss of weight sustained by the egg during incubation. The alkaline matters and chlorine, which have been decreasing from the commencement of incubation, have now undergone farther diminution in quantity, while the earthy matters have increased in the most striking manner. The other principles seem to have suffered very little change in quantity. The following are the results of the analyses of the above two eggs:

	No. I.					No. II.				
	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. Carb. of do.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.	Potash, Soda, & Carb. of ditto.	Lime, Magne. Carb. of do.
	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.	Gr.
Resid. of albumen, membranes, &c.	.04	.12	.09	.23	.12	.03	.13	.09	.25	.12
Animal, -	.44	3.02	.55	2.26	2.58	.21	2.71	.68	2.12	2.60
Yolk, -	.04	1.06	.03	.06	1.26	.02	1.23	.06	.03	1.10
	.52	4.20	.67	2.55	3.96	.26	4.07	.83	2.40	3.82

These experiments, then, demonstrate, or render probable, the following circumstances.

1. That the relative weights of the constituent principles of different eggs vary very considerably.

2. That an egg loses about one-sixth of its weight during incubation, a quantity amounting to eight times as much as it loses in the same time under ordinary circumstances.

3. That in the earlier stages of incubation, an interchange of principles takes place between the yolk and a portion of the albumen; that this interchange is confined on the part of the yolk to a little of its oily matter, which is found mixed with the above mentioned albumen; that this portion of albumen undergoes some remarkable changes, and is converted into a substance analogous in its appearance, as well as in some of its properties, to the curd of milk; and, lastly, that a portion of the watery and saline portion of the albumen is found mixed with the yolk, which becomes thus apparently increased in size.

4. That as incubation proceeds, the saline and watery parts again quit the yolk, which is thus reduced to its original bulk; that in the last week of the process it undergoes still further diminution in weight, and loses the greater portion of its phosphorus, which is found in the animal converted into phosphoric acid, and in union with *lime*, constituting its *bony skeleton*; and, lastly, that this lime does not originally exist in the recent egg, but is derived from some unknown source during the process of incubation.

These, and other interesting circumstances, arising out of the present inquiry, suggest some important hints respecting certain operations of the animal economy. They also serve to direct the attention of the microscopic inquirer to the investigation of points, which it is probably within his power to elucidate, but of which, at present, we are ignorant. This part of the subject, however, cannot be in abler hands than it is at present. To the distinguished physiologists, therefore, who have been recently engaged in the investigation, I willingly leave it, and shall conclude with a few remarks only on the uses of the yolk, and the apparent generation of earthy matter.

Sir Everard Home and Mr Hatchett have concluded, from their experiments, that the yolk is analogous to the milk of viviparous animals, but more concentrated, and that its chief use is to afford a pabulum to the young animal during incubation *. This opinion, which is indeed as old as Aristotle †, is corrobo-

* *Phil. Trans.* Vol. cvi., p. 301., *et seq.*

† Ἡ μὲν οὖν ἀρχὴ τοῦ νεοττοῦ ἐστιν ἐκ τοῦ λευκοῦ, ἡ δὲ τροφὴ διὰ τοῦ ὀμφαλοῦ ἐκ τοῦ ὠχροῦ. Aristotelis de Animal. Hist. vi. 3. (Ed. Schneider)

rated in a striking manner by the present inquiry. Mr Hatchett has also made the important and curious remark, that in the ova of those tribes of animals, the embryos of which have bones, there is a portion of oily matter; and in those ova whose embryos consist entirely of soft parts, there is none. Hence it is concluded, that a certain portion of oil is necessary for the formation of bone. The present inquiry cannot be said to confirm or invalidate this remark, for although in the earlier stages of incubation, before ossification has commenced, a portion of the oil of the yolk is appropriated to the purposes of the economy of the animal, yet by far the greater portion of it remains; and some of it is even retained by the yolk till its final disappearance *. One great use of the yolk evidently is to furnish the phosphorus, entering as phosphoric acid, into the skeleton of the animal; but that the earthy portion of the bones is derived from the transmutation of the oil into lime, cannot, perhaps, be safely asserted in the present state of the inquiry.

With respect to the earthy matter found in the skeleton of the chick when it quits the shell, I think I can venture to assert, after the most patient and attentive investigation, that it does *not pre-exist in the recent egg*; certainly not, at least in any known state. The only possible sources, therefore, whence it can be derived, are from the shell, or transmutation from other principles. Whether it be actually derived from the shell, cannot be determined by chemistry; because, as we have seen, the shells of different eggs differ so much, that the application of averages is out of the question; and we are of course precluded from as-

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Pliny makes the same remark. Ipsum animal ex albo liquore ovi corporatur. Cibus in luteo est. Hist. Nat. x. 53.

* I examined a chick on the eighteenth day after incubation. The yolk was now reduced to less than 2 grs., but it was of its original yellow colour, and of course contained oily matter When burnt, it left traces of phosphate of lime. Dr Macartney attempts to show that the yolk does not pass into the intestine through the ductus vitello intestinalis, but is taken up by absorption; and an argument he adduces in support of this opinion is, that the earthy matter is left behind in the yolk. In the present instance, however, the quantity of earthy matter was very minute: it had therefore disappeared, as well as the other principles of the yolk. When the chick is younger, the quantity of earthy matter is said to be much larger. Haller asserts that the yolk disappeared about the sixteenth day; and Aristotle long ago remarked, that very little of it was left on the [illegible]th day, after the chick had left the egg.

certaining the exact quantity of lime any particular shell origiginally contains. There are, however, very strong reasons for believing that the earthy matter is not derived from the shell. In the first place, the membrana putaminis never becomes vascular, and seems analogous to the epidermis; hence the lime of the shell, which is exterior to this membrane, is generally considered by physiologists as *extra-vascular* *. It is, therefore, extremely difficult to conceive how the earth in question can be introduced into the economy of the chick from this source, particularly during the last week of incubation, when a very large portion of the membranes are actually separated from the shell. Secondly, Both the albumen and yolk contain, at the end of incubation, a considerable proportion of earthy matter (the yolk apparently more than it did originally); why is this not appropriated, in preference to that existing in the shell? In opposition to these arguments, it will be doubtless stated, that the shell of the egg becomes brittle at the end of incubation, and appears to undergo, during that process, some other changes not at present understood. To which it may be answered, that this brittleness has been attributed to the separation of the membrana putaminis, and the exsiccation of the parts by so long an exposure to the heat necessary to the process of incubation; and in this manner, all the *known* changes produced on the shell by incubation may perhaps be satisfactorily accounted for. Until, therefore, it be demonstrated that some other changes take place in the shell, I confess this argument does not seem to me to have much weight. I by no means wish, however, to be understood to assert, that the earth is *not* derived from the shell; because, in this case, the only alternative left me, is to assert that it is formed by transmutation from other matter,—an assertion which I confess myself not bold enough to make in the present state of our knowledge, however strongly I may be inclined to believe that, within certain limits, this power is to be ranked among the capabilities of the vital energies.

* See an Essay "On the Connection between the Vascular and Extra-vascular Parts of Animals," by Sir A. Carlyle. Thomson's Annals, vol. vi. p. 174.

ART. XII.—*Notice of the Attempts to reach the Sea* by Mackenzie's River, since the Expedition of Sir* ALEXANDER MACKENZIE.

THE 4th Volume of the Memoirs of the Wernerian Natural History Society, lately published, contains a series of interesting papers, on zoology, botany, mineralogy, geology, meteorology, and hydrography. The activity of this association is highly creditable to the Edinburgh School of Natural History; and the perfect freedom of discussion displayed in all its memoirs, from the first establishment of the Society to the present moment, demonstrates the right feeling which actuates those naturalists, who, by their learning, zeal and activity, have procured for it so distinguished a rank in the scientific world The notice here reprinted *, we are confident will be read with interest by our readers, and the more particularly at this moment, when the public attention is powerfully attracted towards the northern regions of the earth, by the expected appearance of the Journals of Captain Franklin and Dr Richardson.

The North-West Company first established a fur-post on the banks of Mackenzie's River in the year 1795, and have ever since maintained a greater or smaller number of establishments on various parts of its course. At present, the lowest or most northerly post is Fort Good-Hope, situate about 100 or 120 miles below the influx of Great Bear-Island Lake River, and, as is supposed, about three days' voyage in a light canoe from the sea, which, with the current of such a river, is usually estimated at from 50 to 80 miles *per* day. From the summit of a small hill behind the Fort, the upper limb of the sun is just visible at midnight, on the 21st of June.

In the immediate vicinity of Fort Good-Hope, and on the east side of the river, the Hare Indians reside; and their lands, to the northward of the very extensive piece of water which is named Great Bear-Island Lake, and which is said to be inferior in size to Lake Superior alone, borders upon the Eskimaux

* Read before the Wernerian Society, 17th November 1821, and inserted in the 4th volume of its Memoirs, recently published.

grounds, which skirt the sea-coast. The Fort is also visited by the Loucheux, or Squint-eyes, who inhabit the west bank of the river, and who are separated from the Eskimaux by the Vermilion River, about 2½ days' voyage below Fort Good-Hope. At this boundary they often trade with the Eskimaux, and obtain, at a high price, certain smooth sea-shells, to be inserted as ornaments into the septum of the nose. They have also obtained at these friendly meetings, strips of whalebone, and pieces of the skin and other spoils of sea animals. Notwithstanding this occasional friendly intercourse, however, these two tribes more often enter each other's territories in a hostile manner; and so many of the Eskimaux have been cut off, that that nation is justly very jealous of the visits of strangers.

Two attempts have been made to reach the sea since the period of Sir Alexander Mackenzie's voyage. The first, by Mr Livingston, in the year 1799; when that gentleman, accompanied by James Sutherland, an interpreter, three Canadians, and three Indians, descended in a bark-canoe, a little below the Vermilion River above mentioned. Here they met with a single Eskimaux in his small seal-skin boat, whose first act, notwithstanding the disparity of force, was to discharge an arrow, which penetrated through the sides of the large canoe. They approached him, however, and adopting the mode in use among the Indian nations of discovering the intentions of strangers, presented him with a portion of meat, having first chewed a bit of it themselves. He threw it away with disdain, and refused to receive any of their presents; but directed them to put ashore, and made signs that his countrymen were at no great distance. They complied with his request, whilst he proceeded down the stream; and in a short time returned, accompanied with five of his companions, each in his small canoe, and armed with a bow and arrows. Mr Livingston endeavoured to conciliate them by presents of beads, and other articles; but instead of appearing pleased and grateful, they tied the strings to a pole, and cut them in pieces with their arrows. The Indians now warned Mr Livingston, that he would in vain attempt to establish a friendly communication with such people in their present state of mind, and were urgent for immediate embarkation, when it was discovered that the paddles of the canoe had been conveyed

away by stealth. Such an unequivocal demonstration of a hostile purpose, increased the apprehensions of the party, and they hurried into the canoe, but were instantly assailed by a flight of arrows from the Eskimaux, each of whom shot three from his bow at a time. Mr Livingston and a Canadian traveller fell under the first discharge: two of the Indians, who had not yet embarked, but were holding on the bow of the canoe, let go, and escaped into the woods, whilst James Sutherland and the other survivors floated down the stream. Tney were instantly pursued by the Eskimaux in their boats, and the Indians from their hiding places observed the conflict to be carried on until five of the Eskimaux were killed, and James Sutherland was left alone in the bow of his canoe, which was in a sinking condition. This much was learnt from one of the Indians, who travelled to Fort Chepewyan with the account of the melancholy catastrophe, having, in his route, had his wants supplied by parties of the Loucheux, and other nations he fell in with. It was afterwards ascertained, through the medium of the Hare Indians, that the canoe had drifted down opposite the main encampment of the Eskimaux, and that James Sutherland there threw himself into the water, swam ashore, and placed himself betwixt the knees of an elderly man, for protection. A consultation being now held, his destruction was decided upon; and as he was judged invulnerable from his having escaped from the conflict without a wound, they effected their purpose by tying a stone round his neck, and throwing him into the river; his protector having, in the mean time, conveyed himself away, it being contrary to their ideas of humanity, that he should witness the death of his protegé.

The year following this tragical event, a party of the Red-knife or Copper Indians, making war upon the Eskimaux, at the mouth of the Copper-mine River, found some part of the clothing of Mr Livingston's party in the huts of those they destroyed.

A second attempt to reach the sea was made by Mr Clarke in 1809. He descended the river as far as the assemblage of islands which form the various channels of which Sir Alexander Mackenzie speaks; but here a numerous party of Eskimaux, occupying both banks of the river, put themselves in such a me-

nacing attitude, that it was deemed prudent to return, without making any attempt either to land or to proceed farther.

In 1810, a large shoal of porpoises came up to Fort Good-Hope, to the great grief of the natives, who declared that such visits were always attended by a falling off in the fishery, which accordingly proved very bad that season. This fact, we think, tends to prove the near vicinity of the sea, and that Sir Alexander Mackenzie either actually saw it, or was within a very short distance of it.

The country through which Mackenzie's River flows, appears to offer a fine field for naturalists, and we have had many interesting accounts of it from those who have resided there. It is well worthy the attention of a mineralogist, who would have an opportunity of viewing the operations of Nature on a grand scale. The Rocky Mountains range along the western side of the river, at a greater or smaller distance from its banks; in some places receding to the distance of 70 miles, at others approaching the very verge of the stream, and at one spot below the Great Bear Lake River, a continuance of the same ridge appears on the eastern side of the river.

A kind of sheep frequents those mountains, which, from description, appears to resemble, or to be the same, with the *Argali*, or *Ovis montana*. It has very large, striated, spiral horns, and is clothed in the winter with a thick coarse coat of hair, like that of the rein-deer, which falls off in the summer, and is succeeded by a shorter and finer covering *. There is another animal of still greater interest, which the traders call the Goat, and which would appear to be a species of antelope †. Its horns smooth, short, and black, are directed backwards, with a slight curvature. It is about the size of a sheep, and, in the winter, has a coat of long curled hair, said to be of a silky fineness and lustre. It springs with great agility from precipice to precipice, and possessing, like the sheep, a very quick eye, its capture is attended with much difficulty. I have heard that the skins of these animals have been sent to Europe; but neither of

* The animal described in the text appears to be the Rocky-mountain Sheep, noticed by Professor Jameson in the 5th volume of this Journal, p. 138.

† Specimens of the head of this animal were sent from Hudson's Bay by William Auld Esq. to Professor Jameson, and proved to be the true Argali.

them have hitherto been taken alive. A very large kind of rein-deer is also found on those mountains.

The natives make knives of a white translucent stone, which they detach in large sharp-edged flakes, by greasing a portion of the rock, and kindling a fire upon it.

They also dig up an edible unctuous earth, similar, probably, to that which is found at the mouth of the Orinooko; and use as a pigment a mineral substance, which they find at the bottom of a small subterraneous stream. It is in the form of round, flattish, ponderous grains, of a shining black colour, with a greasy feel, and adheres to the skin only when mixed with grease. A large specimen of native silver was also found in that neighbourhood in 1796.

Near the Great Bear Lake River, there are some coal-mines on fire. And there are several fountains of mineral-pitch, one in particular, which rises in the channel of the river, at a spot which, from that circumstance, is named the Flaming Point.

Art. XIII.—*On the Magnetism of the Brass-work of Surveying Instruments.* By Mr J. Bywater. In a Letter to Dr Traill. Communicated by Dr Traill *.

Dear Sir,

While residing at Nottingham in the year 1810, some magnetical facts came to my knowledge, which may not be unworthy the notice of the Literary and Philosophical Society. During the above period, I was applied to by a respectable house in the neighbourhood to repair, or more properly correct,

* A fact similar to that described in the following paper, was communicated to us some time ago by Mr J. Napier, R. N. who observed it at Halifax, Nova Scotia, in the summer of 1821. When he was making some observations on the variation of the compass, he was surprised at the sluggish and unsettled motion of the needle, and was led to conjecture that some part of the brass-stand belonging to the instrument which he used was magnetic. Upon making the trial, he found this to be the case, and the degree of magnetism was such as to draw the needle from 15 to 20 degrees out of its place, and to retain it in that position when it was in contact with the brass.—Ed.

a miner's dial. In repairing and adjusting this instrument, a regular attention was paid to those parts on which the correct action of the instrument depends; but after this had been done, the dial still remained imperfect, sometimes pointing correctly, while at other times its indications were quite erroneous. To counteract this irregularity, new agate-caps and needles were applied, some of which were procured from one of the best makers in London, and the others were got up by an expert country workman; yet the irregular action of the dial still continued, and the case seemed too difficult and perplexing to admit of a remedy.

Under these disappointments, it occurred to me that the brass-work belonging to the instrument might be so far magnetic, as to produce the irregularity in question; a conjecture which experiments proved to be true, for both the limb and ring were strongly magnetic. As a further proof that this was the source of the erroneous action, the above two defective parts were replaced by Mr Bate, and then the instrument became uniformly correct.

Just after the dial had been put in good order, a person called upon me, and, seeing the instrument, observed I had got "a dial that was bewitched, for it had led many workmen astray; and that he and five men had nearly been plunged into an old shaft by its incorrectness." Upon further inquiry, he told me that it had been sent twice to the maker's in London, three times to Derby, and twice to Nottingham, to be put in good condition; but all of them returned it imperfect. Had these facts been stated to me when I received the instrument, most probably I should have suspected the character of the brass, without such a waste of labour, though nothing of the kind had occurred to me before.

The accompanying limb or plate you will find strongly magnetic, though it has been laid aside between ten and twelve years.

I have chiefly been induced to recall the particulars of this subject to mind, by a conversation I lately had with a gentleman from Staffordshire, or Shropshire, who informed me that he had laid out between two and three hundred pounds in surveying instruments of this kind, and yet he had only one on which he could depend.

These facts shew the necessity of examining whether the brass of which delicate instruments are to be made is magnetic; and if you think these observations worthy of further publicity, they are at your service. I remain, Dear Sir, yours truly,

LIVERPOOL, *Jan.* 8. 1822. J. BYWATER.

ART. XIV.—*Account of the Great Waterfalls of Rewah* *.

HAVING encamped for the night at Gungeoh, we marched the next morning to Kaioutee, where the first of the Falls is situated, about 9 miles from our former Camp, travelling in a westerly direction through a level and well cultivated country. Nothing is either heard or seen of the Fall, till you approach within a few hundred yards, when all at once a deep and precipitous chasm in the earth is presented to the eye, and the roaring of water announces it to be near at hand. On advancing by the south side of the stream, which forms the cascade, and is called the Mahanuddy, a spectator is compelled to cross, so as to obtain a complete and perfect view of the fall, which flows into a circular bason, projecting inwards, and forming a kind of dock, from which the water empties itself at the farther end. The opposite side of the pool is the best place to view it; its bank being considerably raised above the top of the fall, commands a fine and extensive prospect of the scenery, above, below, and around. On a rising ground, covered with jungle, situated between the Mahanuddy and a dry dell, which, during the rains, the natives say is filled with water, stands a Hindoo temple, conspicuous neither for neatness nor elegance of architecture, but plain and dirty in the extreme.

This hillock, during the months of July and August, is an island, being surrounded on three sides by a torrent of water,

* These stupendous waterfalls are on the rivers Mahanuddy, Behur and Touse, in the province of Gundwana. The following account of them, drawn up by an Officer of the 8th Light Cavalry, is abridged from the Calcutta Journal of the 17th January 1822.

and having the other facing towards the precipice bounded by air. On the right, but farther down the glen, and at the top of a high and rocky bank, having its surface overrun with jungle, is situated the Fort, which has certainly a bold and imposing aspect. It extends along the cliff for about 200 yards, flanked at each end by a bastion; the other sides, looking to the villages, in the rear of which our camp was pitched, seemed to be weak and irregular. It is surrounded by a wall of unequal height, but no ditch; and only that side facing the glen shows any strength, or at all has the appearance of a fortification.

Having made these preliminary observations, the better to point out the exact situation of the "Fall" with regard to the surrounding objects, it becomes necessary to speak of its height, appearance, and the body of water which rushes over. I confess I was somewhat disappointed at the small quantity, comparatively speaking, which issues into the bason, and which assuredly fell short of my expectations. However, it is to be remembered, that this is almost the very worst season of the year for viewing it to advantage, and you are to consider whilst beholding it, how awfully grand and majestic it would be, during the season of the rains, then in the height of its glory, and pouring down with tremendous impetuosity, sweeping before it every thing that impedes its progress, and carrying into the abyss rocks, trees, and sometimes even cattle. The Fall now consists of nine smaller and two larger streams, but joined one with the other, on account of the foam and spray, which issues from either side of these bodies of water. The stream for half way down the precipice has the appearance of pure white cotton: it then rushes down in the shape of fire-rockets flying into the air, but of course reversed. The spray is seen rising from the pool like smoke or mist, and the whole of the bason is agitated like the water of the sea, and the margin similar to the ebbing and flowing of the tide.

The scenery around, so wild and solitary,—the roaring of the cataract so impressive and solemn, with the gloom and dismay of the dell beneath, cannot fail of raising lofty and sublime ideas in the breast of the spectator, and rendering it at once deeply interesting and terrific. The exact height, as measured by an officer of this regiment, is 270 feet, from the lowest part of the

rock to the surface of the water in the pool; and I have no doubt if it had been measured from the highest point, there would have been a difference of at least 30 feet.

We descended into the glen by a narrow and precipitous foot-path, much impeded by jungle and rocks: here we had a much better view of the Fall than from above, and were more able to judge of its true depth. The bason is full of alligators, which we had amply proved, seeing one basking on a rock in the sun, and finding the bleached skeleton of another's head underneath a large stone. A dead carcase was also lying at the bottom, but how it got there, is impossible to tell, unless carried down by a tiger; and from there being no deer, or other kind of prey, in this part of the country, we inclined to believe there can be no tigers near. After remaining for an hour to rest us after the fatigue, we began the ascent by the opposite side from that which we had come down, which was the left, and found it more steep and difficult of access. Having climbed for an hour and a quarter over rocks and stones, we at length reached the top, just under the south bastion of the Fort.

As I have now spoken at sufficient length of the "Fall of "Kaioutee," I shall proceed to relate our journey to the next, known by the name of the "Fall of the Behur."

We marched again on the morning of the 11th, crossed the Mahanuddy by a difficult and rocky passage, passed through the village of Rajgurh, and, after fording the Behur river, encamped to the north of "Chechai" 3 coss or 11 miles distant from Kaioutee, (for the coss of this country are generally between 3 and 4 miles in extent). This is a pretty little village, with a neat small fort, the residence of the Zumeendar. After breakfast, we walked along the banks of the stream, which is here about 60 yards broad, down to the Fall, ¼ of an hour's walk from camp.

This, like the former, comes upon you on a sudden, and the spectator is immediately struck with the difference of heights, which is here 93 feet greater than the other, the water here falling the tremendous depth of 363 feet, which was measured twice by the same officer as before. The quantity of water is also greater, and falls more in a mass, which gives it a very superb appearance. The bason which receives the Fall is larger, the

dell not so confined, nor the banks so uniformly steep, as Kaioutee; and, although the depth is so much more, the scenery is not so rugged and picturesque, and does not inspire the same emotions on beholding it.

To the brink of the precipice over which the water runs, on either side of the stream, the country is level, and abounding in vegetation, which affords a fine contrast to the rocky cliffs below, and transports the eye in an instant from the extremity of sameness and flatness, to that of ruggedness and grandeur. This glen is more extensive than the other, and, a short way from the Fall, branches off to the right and left; the former, I believe, is the main outlet to the stream, which afterwards joins the Touse in a valley called the Terai. We descended here likewise, crossed the *nullah* at the bottom, which is broad and rapid, and ascended by the other side, with much difficulty and exertion, owing to the closeness of the jungle. By moonlight, I was told, though I did not visit it myself, that the Fall had a beautiful silvery appearance, and was altogether more imposing and solemn, from the silence and stillness of the hour.

We started on the 12th from Chechai at day-break, crossed the Touse at Tahlurk ghaut, to the right of which is the Waterfall, and pitched our tents at Uttereeah, one mile from the river, making this day's journey only four miles. The fall of the Touse is not so deep as the other two, being only 210 feet; but the fall of water is far superior, both from there being a greater body, and from its being divided into two separate and distinct currents.

The grandest of the two, which is on the right, issues down with tremendous impetuosity, and creates a loud roaring noise to such a degree, as to drown all conversation. A break about 12 feet from the top causes the fall to project considerably, and enhances the magnificence of the sight in a high degree. The glen is narrow, and continues to the bottom almost perpendicular: huge ledges of rock, sent from the great mass, and hanging, you would imagine, by a very slender and precarious tenure, present a fine bold and wild aspect. If the height of this Fall had been as great as the others, I should have no hesitation in giving it the preference. In point of scenery, it is unequal to Kaioutee, yet certainly superior to Chechai; but it

is the quantity of water which rushes down, and the last spray that arises from the pool, which render it, especially at this season of the year, a fall of more interest and grandeur than the others. The one to the left flows over natural steps, as it were, hewn in the rock, and is a pleasing contrast to the impetuous torrent on the right. We threw a deceased dog over the larger fall, which went down headlong in capital style, and seemed when it reached the surface of the bason uninjured; but no sooner had this been effected, than it instantaneously disappeared from our view, and though we remained some hours afterwards sitting on the top of the crag, it never again rose. The violence and rapidity of the current must have carried it underneath, where it no doubt sooner or later was swallowed and devoured by alligators.

A curious phenomenon, not only with regard to this, but also to the others, is, that the water, when it reaches the bottom, assumes a *dirty green appearance*, similar to the salt-water near the shore, and the taste becomes bad and sour. How this is to be accounted for, I am perfectly ignorant, and should feel obliged to some of your naturalist correspondents to give a satisfactory explanation; but it is to be kept in mind, that the very great depth of the pools, which are said to be unfathomable, does not cause this colour; for that which issues out of the basons, and runs over rocks, so shallow as not to come much above the ancle, has the same green aspect. The glen of the Touse is narrow and perpendicular, and does not admit of a person approaching immediately under the fall, as we did at the rest, on account of the water extending about 40 yards down the dell, from side to side of the descent, and the steepness of the rocks prevents there being a passage on either bank.

I shall conclude this letter, by observing, that we were all most highly gratified by the sight of those superb natural curiosities, which are the highest waterfalls known in the world, the highest Fall of Niagara being only 163 feet, and thus making the Fall of Chechai 200 feet greater than that which was once supposed to be the most lofty in the universe!

It may be said, however, that the river St Lawrence being a very large and noble stream, the fall must of course be far more magnificent and grand than any of those which I have at-

tempted to describe. That this may be the case in some degree, is true; for it is impossible that either the Mahanuddy, the Behur, or the Touse *, can vie with the St Lawrence; but take the romantic scenery of the first, the great height of the second, the quantity of water and rugged rocks of the last, and contrast them, in a body, with the Falls of Niagara, there cannot be the shadow of a doubt that they would be considered, during the season of the rains, as infinitely more worthy of being recorded and admired than those I have last mentioned, the celebration of which has occupied the pens of so many poets and travellers.

ART. XV.—*Detail of Experiments on the Ignition of Wires, by the Galvanic Battery.* By JOHN MURRAY, F. L. S., M. W. S., &c. Communicated by the Author.

THE following experiments on the ignition of wires may perhaps not be altogether uninteresting. Being connected with the phenomena of caloric developed in the action of the galvanic battery, I trust they may be acceptable as a contribution toward that mass of facts which may, at some future period, assume a more scientific form.

In these experiments I used four porcelain troughs, each containing ten cells, and each cell supplied with $1\frac{1}{2}$ fluid ounce of the strongest *nitrous acid*, being filled up with water to the depth of two-thirds, and properly mixed with a glass rod. Nitrous acid in this proportion, I have ever found best calculated for the development of galvanic action. *Fifteen to eighteen inches of fine platinum wire* may be readily ignited. I of course use the *triad* (4 inches square), for which we are indebted to the sagacity of that ingenious and profound philosopher Dr Wollaston.

When *sulphuric acid* is employed, as is done, most injudiciously as I think, by some, in mixture with the nitrous acid, the vapour is perfectly intolerable, and much of the action is no

* The following are the computed Breadths of the Rivers above the Falls, when filled with water during the Rains:—

Mahanuddy,	-	-	100 yards.
Behur,	-	-	120 yards.
Touse,	-	-	350 yards.

doubt lost and expended therein, and in the great temperature developed at the same time.

In connection with the subsequent detail, I may be permitted to mention, that a ribbon of platinum foil, suspended from one of the conductors, and brought in contact with the mercurial surface (that metal being contained in a shallow glass-basin), while the other one is plunged into the mercury, deflagrates with great brilliancy, and *oscillates like a pendulum.*

I may now state generally, that steel and platinum wires may be *intensely ignited,* in *alcohol, ether and its vapour, oil of olives, naphtha* and *sulphuret of carbon.* I have not succeeded in igniting these in *water,* and conclude that it is owing to the superior conducting property of that fluid. The degree of ignition, all circumstances being the same, will correspond with the relations in which the medium containing the wire stands to conduction.

Platinum and steel wires may be ignited in *carbonic acid-gas, hydrogene, cyanogene,* and *olefiant gas.*

Gold-wire was wrapped round *platinum* in all *its extent;* and this double wire placed as the uniting wire between the conducting rods. It was *ignited throughout,* and the fusion of the gold-wire supervened, the gold being collected into little spheres of a prolate form, at equal distances, and appearing like a row of beads.

Steel-wire was, in like manner, entwined with gold-wire. It also was *ignited in its whole extent;* the gold-wire was fused, and exhibited the bead-like form.

Platinum was woven with copper-wire. The *platinum*-wire was *ignited throughout;* the copper-wire not undergoing fusion, nor even ignition.

It may here be remarked, that, in the ignition and combustion of steel-wire, for instance, the fusion is *primarily confined to the surface,* and the fused scale or film may, perhaps, not penetrate more than $\frac{1}{3}$ the diameter of the wire, while the remaining part may not have undergone the least physical change. The fused matter formed itself into spherules, with regular intervals. This appears to me to be a curious phenomenon; and it will also be observed, that when the calorific effect is short of ignition, the steel-wire will be *blued in patches.*

Steel-wire was *doubled* for *one-half its extent*; the *single and denuded* part was *alone* ignited.

Platinum-wire was doubled for *one-half its extent*; and that part *only* which was *single* could be ignited.

Steel-wire was partly enveloped in gold-wire; *only* that portion of the steel-wire which was *void of the gold-wire* could be ignited; the part encased in the folds of the gold-wire was partially *blued*, and was rendered *magnetic*.

Copper-wire was twisted round platinum-wire, for half the length of the latter. The *uncovered platinum* was *alone* ignited.

Copper-wire was twisted around steel-wire in the manner of the preceding; the *naked steel-wire* was ignited alone.

Steel-wire was twisted round platinum-wire, for one-half its length; *only that portion* of the platinum-wire excepted from the steel could be ignited.

Peculiar phenomena are connected with these exhibitions. When the second wire is *carried through the whole extent of the uniting wire*, ignition is superinduced *throughout*; but when only *partial*, the ignition is *confined to the denuded portion*.

Copper, platinum, and *copper wires*, were linked together, and made the communicating chain. The *platinum* placed between the copper-wires was ignited alone.

Platinum, copper, and *platinum wires*, exhibited, on the tract of either *platinum-wire*, ignition, while the intermediate copper-wire remained dark and unignited.

In the case of *steel, copper*, and *steel wires* (so linked together), the *steel-wire* on each side was ignited, while the copper-wire remained unaltered.

In the chain of *platinum, steel* and *platinum wires*, the platinum-wires were *exclusively* ignited, and the steel unignited.

In that of *steel, platinum* and *steel*, the intermediate link of *platinum* was ignited, and the steel-wire on each end remained without ignition.

In a chain of *gold, steel* and *gold*, the *gold-wires* on each end were *ignited and fused*, and the intermediate steel was not ignited.

In one formed of *steel, gold* and *steel* wires, the central *one of gold* was exclusively ignited.

I next tried *spiral coils* of *platinum* and *steel*, of various diameters, and found that they were ignited, though curvilinear, in the same manner as if the wires were not curved.

The preceding experiments seem to prove, that the caloric developed in galvanic action, has no relation with the medium *in which the ignition takes place; and that it is evolved in* some inverse ratio of the conducting properties of the uniting wire.

The phenomena of ignition in links of various metals united into a chain, seem connected with the passage of a *material agent* through them, displaying its powers in greater or less ignition, according as the passage is interrupted, or its fire more or less retarded, and, of course, as the amount of the resistance.

The agent or agents, therefore, developed *in transitu* from pole to pole, will therefore swell into ignition, if the conducting power of the medium traversed is low, or even burst its metalline confine, and expend its impetus in all the brilliancy of an intense combustion.

The *gold, platinum and copper wires* were $\frac{1}{100}$th inch in diameter; and the *steel* the finest harpsichord-wire.

ART. XVI.—*Observations on the Tutenag and White Copper of China.* By SIR THOMAS DICK LAUDER, Bart., F. R. S. E.

DEAR SIR,

I OBSERVE in the last Edinburgh Philosophical Journal, an account of "The analysis of Tutenag, or the White Copper of China," by Dr Fyfe. That ingenious chemist remarks, that very different statements have been given of the composition and origin of *Tutenag*; but it appears to me, that these seeming discrepancies may have arisen from the promiscuous use of these names given to two substances which are in reality perfectly distinct.

An intelligent friend of mine, who was employed for many years as captain of a vessel in the trade between China and India, happening to be with me at present, I am enabled to state, from him, that the substance analyzed by Dr Fyfe is not Tutenag, but White Copper, the properties of which are totally different.

The white copper is used by the Chinese themselves, who are so jealous of permitting other nations to have it, that its exportation is contraband. In defiance of this, however, considerable quantities of it are smuggled out of the country, and introduced into India, where it is considered as a great present to the Hindoos, &c. who make domestic vessels of it. The Tutenag, on the contrary, is an article of very extensive commerce between China and India; and my friend informs me, that it is sent from China in slabs, of which he has had occasion to buy and sell many thousands. The slabs are about eight or nine inches long, by about five and a half wide, and about five-eighths thick. Its colour is greyish; and it is not malleable, but so brittle that it is even necessary to use considerable caution in putting it on ship-board, to prevent its being broken by one piece striking against another. The fracture has a glittering lustre, and somewhat resembles the appearance exhibited by that of bad iron; but the crystallization (if such a term may be employed) is larger. It does not ring, but emits a heavy clattering sound. It is employed by the natives of India as an alloy for copper, to make brass for their domestic utensils.

I consider it right to send you the above information, as I think it may perhaps be interesting to your readers. I remain, my Dear Sir, yours faithfully,

RELUGAS, 11*th July* 1822. THOS. D. LAUDER.

ART. XVII.—*On the Fresh-water Formations of Italy, posterior to the Coarse Limestone.* By ALEXANDER BRONGNIART, Member of the Institute of France, &c. &c.

M. OMALIUS D'HALLOY, was the first geologist who referred to the fresh-water formations, the calcareous rocks, so well known in the neighbourhood of Rome and of Sienna, under the name of *Travertino*; and who showed, that, with the exception of fresh-water shells, which he could not discover in the travertines of Tivoli, this limestone presents otherwise all the characters of texture in the small, and of position and relation in the great, which belong peculiarly to the lacustrine formations, such

as we have characterized them. It presents especially, those singular sinuous canals, so constant in the lacustrine limestone of all countries, tubular cavities, which have not escaped the observation of so acute a naturalist as M. Von Buch; for this geologist has described them with perfect precision, before being aware of their importance, as furnishing a general character of these formations.

The extent of this fresh-water formation in the south of Italy, together with its importance in a geological point of view, and with reference to the arts, induce and authorise me to enter into some details upon the subject, in order to determine the circumstances of its formation and its position, relatively to the other formations

M. Omalius d'Halloy, has discovered these formations at the entrance of the Pontine marshes near Cisterne, at the foot of the volcanic hills of Velletri, in a low plain. It is a compact and solid white limestone, perforated by a great number of tubular cavities, containing limnææ and globular helices: he supposes it covered in many points, like that of Auvergne, by volanic brecciæ. It appears that this limestone occurs farther south towards Calabria; for the temples of Pæstum, in the Gulf of Salerno, are said to be built of a brecciated stone, which is undoubtedly travertine.

This formation first occurs indistinctly at Monte-Verde, to the south of Rome. It is found, again, very well characterised in Rome itself, then of considerable extent and thickness at some distance from that city, towards the east of the Tivoli side, and to the north-west of the Civita Vecchia side. It is by examining it at these different points, that I purpose to distinguish the different circumstances of its geognostical position.

At Monte-Verde, it shows itself only in a thin bed, which is interrupted and even destitute of its essential characters; it is placed upon a siliceous sand, mixed with some augites, which covers a perfectly homogeneous earthy volcanic tufa.

In Rome, M. Brocchi, with whom I have had the valuable advantage of visiting these places, pointed out to me the fresh-water limestone at the eastern foot of the Aventine Hill, on the banks of the Tiber, in the place called the *Cavern of Cacus.* It is compact, contains some fresh-water shells, lies upon a red-

dish and earthy volcanic breccia, and is not covered by any rock.

The plain which extends from Rome to the foot of the mountains on which Tivoli is situated, is covered in a large portion of its extent by a great deposit of travertine; it commences at Martellone, on the road from Rome to Tivoli, and continues almost without interruption, to the foot of the Tivoli mountains. This plain, in which are situated the quarries of Ponte Lucano, which furnish the travertine employed in building, may be considered, as M. Omalius d'Halloy says, as the bottom of a great lake, traversed at present by the Tiverone, bordered by volcanic brecciæ, raised by calcareous depositions, and almost dried by this raising; for it is not completely dried, and with M. Omalius d'Halloy, we may consider as the remains of this vast mass of water, the small lakes of *Tartaro*, *Solfatara*, and others, which seem still to exist, for the purpose of showing us some of the circumstances under which fresh-water formations have been produced.

The geologists who have examined this formation, and particularly Messrs de Buch and Omalius d'Halloy, have observed,

1st, That the lower and old travertine, whose formation does not go on at the present day, is the only one employed for building, as possessing sufficient compactness and solidity; that which is daily formed by the waters of the lake of Solfatara and of the Teverone, is not dense enough: 2dly, That the fresh-water shells are of extremely rare occurrence in it, for not only was M. Omalius d'Halloy unable to discover any, but he thinks that their absence is owing to the influence of the sulphuretted hydrogen gas existing in these waters in a state of solution, and which precludes the possibility of lacustrine mollusca living in them.

The great difference of circumstances between the lake of Tartaro and the lake of Solfatara, agrees very well with this theory.

The waters of the first are clear, its banks are covered with calcareous incrustations, having a crystalline structure, but we see that they are old, and it does not appear that the present waters have the property of depositing them. The bottom of this lake is also covered with vegetables, and its waters are peopled with all sorts of animals, frogs, insects, &c.

The lake of Solfatara nearer the foot of the hills is altogether different. It is a considerable mass of whitish waters, from which bubbles of air, and a very distinct smell of sulphuretted hydrogen-gas are continually disengaged. They deposit on the vegetables which grow on the banks and in the canal, by which they find an exit, a thick layer of white limestone, with a compact texture, a true travertine.

When the bottom of this lake is stirred, a considerable disengagement of gas is produced. The water acquires along the line of passage of the gas, a degree of limpidity which is, without doubt, owing to the solution of the limestone by the carbonic acid which is disengaged. There is not a single living creature in the waters or on the banks of the lake, at least we saw none.

The differences which these two lakes present, seem to be in relation with the differences often presented by the lower and upper parts of fresh-water formations. That of Solfatara shows the phenomenon of the calcareous formation in its period of activity. The waters are too much impregnated with gas and earthy matter to allow animals to live in them; and in consequence these first calcareous deposits should not contain them at least in the places near the issuing of the spring; but in proportion as the mass of mineral matters diminishes, or, as the canals are filled up by the depositions, the waters become less impregnated with gas and calcareous matter, the deposition less rapid and more crystalline, animals can live, and this deposit, containing the remains of these animals, is necessarily superior to the former. This is probably the state in which the *Lago de Tartaro* actually exists; and this relative position of the fresh-water formation without shells, and of that containing them, is precisely what has been observed in all places where these two formations are known to exist: thus, in the basin of Paris, the siliceous limestone without shells is placed beneath the fresh-water shelly limestone; the millstone without shells is inferior to that containing them, &c.

We find, therefore, here an association of phenomena, and circumstances, which permit the employment of direct observations equivalent to facts, to lay the foundation of the theory of

the formation of fresh-water deposits, and perhaps even of many others, and to induce us to presume that many calcareous formations have been produced, like the travertines of the plain of Tivoli, by numerous springs issuing from the ground impregnated with a solution of carbonate of lime, which they have deposited with greater or less rapidity at the surface of the soil.

These considerations seemed to me of sufficient importance to engage our attention for a few moments; for they contribute essentially to complete the history of a formation which was first observed in the neighbourhood of Paris.

But the travertine or fresh-water formation of the plain of Tivoli is not utterly destitute of the remains of mollusca. I have seen them near the Villa Adriana, even at the foot of the hill, in a limestone cliff, which, besides discloses in a very evident manner its position with regard to the other formations.

The fundamental rock of the Tivoli mountains is a fine compact limestone, including uninterrupted beds or nodules of hornstone, and which appeared to me to have a very perfect resemblance to that of Jura. Sometimes the fresh-water limestone rests immediately upon this ancient rock, sometimes it is placed upon a volcanic breccia, which itself reposes upon this compact limestone. The place which I have mentioned shows this interposition in the most evident manner. We find, on proceeding from the surface of the soil downwards, 1st, A compact travertine with sinuous tabular perforations and some shells; 2d, A mixture of friable travertine and debris or volcanic breccia. 3d, A pretty large bed of this breccia.

Thus, all the facts observed by M. Brocchi, and which I have had an opportunity of re-examining along with him, together with those which I have observed myself, establish for the position of formations analogous to those of the neighbourhood of Paris, as well at Rome as in its neighbourhood, the following is the order of succession, proceeding from below upwards.

1*st*, A compact limestone, analogous either to the Jura limestone, or perhaps even to chalk. The petrifactions alone, when they occur, and they are very seldom seen in it, might resolve these doubts.

2d, The coarse sandstone formation, composed at its lower part of bluish argillaceous marl, with shells, and towards its upper part of reddish sandy limestone, and sometimes of marine sandstone, as it occurs in perfection in Rome, at the foot of the *Monte-della-Grita,* a small hill parallel to the Janiculus, and which is itself a detached part of the same hill.

3d, The volcanic breccia, in all its modifications, lying above this formation, as it is very distinctly seen at Mount Marius.

4th, Lastly, The fresh-water formation. It would, therefore, be here in a different position from that which I have examined in Cantal, in the department of the Puy-de-Dôme, and in that of Allier. These might be referred to the middle or gypseous fresh-water formations, and those of the Roman states to the fresh-water formations superior and posterior to the second marine formation: and this relation still agrees perfectly well with the position which M. Prevost has assigned to the coarse limestone formations of the Apennines.

I have said, that there are also pretty considerable formations of fresh-water limestone or travertine, on the side of Civita Vecchia. We begin to see it forming large flats, near Mala Grotta, and at Suido. It ceases afterwards, but after having passed the Pulidoro, and the hamlet of this name, we traverse considerable masses of fresh-water limestone, which form projecting, and as it were protuberant parts, which have the appearance of being advanced toward the sea in the manner of a bed of lava. It is at Monterone that it is most abundant, and in the greatest masses. It rests here upon a rock which possesses all the characters of the transition formation.

The celebrated falls or cascades of Tivoli are not owing to cliffs of the compact limestone, which forms the mass of these mountains, but to a damming (banage) of the valley, produced by depositions from the waters which flow through it, and which had, in earlier times, been more impregnated with calcareous matter, than they are at the present day. This agitation of the waters gives to the deposit undulations, which it is not seen to have in the plain, and the less abundant precipitation permits the limestone to assume a crystalline texture and aspect, which gives it more of the nature of alabaster than of travertine. This same disposition, dependent upon the same causes, is observed

in all its details, at the beautiful cascades of Terni. We find, at first travertine, or compact fresh-water limestone in the neighbourhood and lower parts, and near Rieti, at the confluence of the Velino and Nera. This small river precipitates itself in the form of a cascade, from a barrier of crystalline concretionary limestone, formed by the same means, and on the same fundamental soil of compact limestone as at Tivoli. M. d'Halloy has seen fresh-water shells enveloped in the concretionary limestone.

The fresh-water formation presents, at the place mentioned, the banks of Saint Philippo, at some miles to the north-west of Radicofani, on the frontiers of Tuscany, a locality cited in all the works on mineralogy, for the application which Dr Vegni has made of the property which these hot-springs possess, of depositing a great quantity of very fine and white calcareous matter, to the fabrication of very beautiful bas-reliefs. Not only is the origin of the fresh-water formation here evident, but this deposit is in so distinct a situation, that this place might serve, so to speak, as a model for giving an idea of the formation of hills, and even of a great number of calcareous mountains.

In fact, the springs impregnated with carbonate of lime, issue in abundance from the fundamental soil, which is a fine compact limestone, of a greyish colour, which might be referred to the alpine, or even to the transition limestone: they issue towards the bottom of a valley hollowed out in this limestone, and they have raised in this valley a true hill of white concretionary limestone, sometimes compact, more frequently crystalline, and having a fibrous structure. This hill of modern formation has very steep slopes, which are, however, interrupted by small terraces, and terminated by a rounded platform, on which the baths and hamlet of Saint Philippo are built, and where gardens and various kinds of culture are established. This limestone formed successively, and in contact with the air, has not the compactness and fineness of grain possessed by that deposited at the bottom of a lake: it envelopes organic bodies of all sorts, but the substance of these bodies is not petrified.

It may be remarked that this calcareous spring, like that of Tivoli, as well as a great number of those in the neighbourhood of Naples, in Sicily, &c.; is upon the limits of volcanic forma-

tions, and that it issues from a limestone which may be referred to the transition formation.

In the places which I have here described for illustration, the origin of the fresh-water limestone is not at all doubtful, and when one sees it forming under his eyes, if we may so speak, at Tivoli, at Terni, and especially at Saint Philippo, and at the lake of Solfatara, he cannot hesitate to attribute the same origin to that which is on the route of Civita Vecchia, the source of which is no longer visible. Now, as the fresh-water limestone, which we find in Tuscany, in the neighbourhood of Colle and Volterra, is absolutely similar, in many of its parts, to that of the plain of Tivoli, there is no need of seeing its source, in order to assign to it the same origin.

This formation is here very remarkable for its extent, for its evident position, and for the great quantity of fresh-water and land shells, which it contains in a state little altered from the original.

It is at the bridge of the Podernia, which is some miles to the north-west of St Philippo, on the route of Sienna, that the hard and compact travertine begins to shew itself anew; but it is at Sienna itself that the fresh-water limestone re-appears in considerable quantity. It continues thus covering the summits of the hills, sometimes descending along their declivities, but ceasing in the valleys, to the passage of the Staggia, on the route of Poggibenzi. It often presents a soft texture, and envelopes stems of aquatic plants and fresh-water shells. These places are now much elevated about the water, as it exists at present, and, from their form and position, cannot receive any stream of water, or retain it in any considerable quantity.

On descending in the valley of Elza toward Colle, we find the same arrangement, that is to say, at first, and on the heights, a very extended, very thick and compact fresh-water limestone, then a fine sand of the same formation, for it incloses a multitude of fresh-water shells, in excellent preservation, some of them retaining even their original colours, and these are Nerites. The other shells are Physæ, Limneæ, Planorbes, some Helices and Paludinæ. We find next, that is to say, on descending towards the valley, not precisely beneath the preceding beds, but always at a level much higher than that of the highest waters, a

formation sometimes compact with siliceous parts, which adhere in its mass, presenting the sinuous cavities and shells which characterise the lacustrine formation, sometimes porous, even tufaceous, and seemingly composed of stems of chara and myriophyllum, petrified into limestone. This formation re-appears on the opposite hill, that is to say, on the left bank of the Elza. It cannot be considered as of modern formation, for it occurs at an elevation, to which the Elza, in its highest risings, never attains, and it rests upon the upper marine formation, which has itself a very great thickness.

The waters which have deposited this formation no longer rise to its level; but we see issuing from the foot of the eminences on the left bank of the Elza, streamlets which turn a mill, and which have the property of depositing a great quantity of calcareous matter. It may be presumed, that before the opening of the valley or water-course of the Elza, these springs issued at the level of the summits of the hills which form its sides. This change has taken place at a period preceding the commencement of historical records, and has happened, without doubt, at the same epoch when the valleys were scooped out, and when the continents, partly laid bare, have assumed, in their lower parts, the forms which they at present possess.

A fresh-water limestone, similar to the more compact parts of the preceding, appears even towards the summit of the hills, above the marine formation, almost every where in the neighbourhood of Volterra. Also at *Castello di Santo Juliano*, we see very high cliffs, which are composed, at their base, of bluish argillaceous marl, with marine shells; towards their middle, of reddish sand with pebbles, sometimes containing oysters, pectens, and some other marine shells; and, at their summit, a very thick deposit of fresh-water limestone, with its tubular perforations, shells, &c.

At Pomarance, to the south-east of Volterra, and, consequently, at a considerable distance from the two places where I have mentioned the fresh-water limestone as occurring, the same formation still presents itself, with the same characters, but not altogether in the same position: for here it seems to have flowed upon the southern declivity of the hill, at the

summit of which Pomarance is situated; it is nevertheless always superior to the marine limestone, and to the gypseous marles which are beneath, because all these formations have followed the same inclination, and seem to terminate here, since, on the other side, we find ourselves upon another formation, composed of micaceous compact limestone, covered with ophiolite.

I shall not prosecute farther my inquiries regarding the fresh-water formations. The numerous examples which I have adduced are sufficient for giving an idea of the great extent of a formation to which, until ten years ago, no attention had been paid; and for presenting to the view of naturalists the remarkable analogy of their characters, in all these places, so remote from each other, and so different with regard to the nature of the subjacent rock.

I have insisted upon the fresh-water formations which are at the present day in the act of forming, because they afford us means of appreciating the causes which may and must have produced the deposits of ancient formation, and consequently of establishing the theory of those of the neighbourhood of Paris. The fresh-water formations of Rome, of Sienna, of Colle, and of Pomerance, are in a geological situation identically the same as those of Fontainebleau, of the Plaine de Trappe, of Montmorency, &c. We cannot refuse to attribute to these calcareous waters issuing from the bosom of the earth, and from beneath the most ancient sedimentary formation, the construction of the fresh-water formations of Italy and Hungary. Results perfectly similar must be attributed to the same cause. We may therefore presume, that the fresh-water formations of the neighbourhood of Paris, are owing to an abundance of calciferous and siliciferous thermal springs, which are dried up, as those of Pomarance already are, and as those of Colle are about to be, whether their reservoir has been exhausted, or their canals obtructed.

It is true that we find, in the neighbourhood of Paris, fresh-water formations entirely siliceous, and that none of this kind occur in the parts of Italy which I have mentioned; but I shall recall to mind, that those of Colle contain very distinct siliceous parts; and, besides, if the examination of this circumstance would not lead me altogether beyond the natural limits

of this work, I might cite examples of thermal springs still containing, in the present state of the surface of the globe, a great quantity of silex in solution.

The fresh-water formations of Œningen have a character altogether different from those of Italy, of the neighbourhood of Paris, and of the greater number of those which I have mentioned, and on this account a different origin must be attributed to them. They may be regarded as sedimentary fresh-water formations, produced almost entirely by mechanical means, that is to say, by earthy matters, often even pretty coarse, deposited more or less rapidly at the bottom of a lake, and enveloping the organised bodies which may occur there. They also present a structure entirely different from the others: the layers are very distinct and numerous; the grain is sandy, and often coarse; lastly, there are none of these tubular perforations, which indicate in the other formations the disengagement of the gas which the limestone holds in solution.

We have therefore two sorts of fresh-water formations, very different in their origin, and distinguishable by external characters, which indicate this difference of origin. The one, produced by solution and precipitation, more or less pure and crystalline, have issued from the interior of the earth with the waters which have carried them to the surface of the soil. They may, according to this theory, be formed at all elevations where similar waters may have issued, and the height at which they occur is not always a proof of that to which the fresh-water has been elevated. These are the most extensive: they are those of the neighbourhood of Paris, of Locle, of Italy, &c.; they are rarely mixed with bodies of marine origin.

The others, of coarser texture, resulting, so to speak, from the abrasion and washing of the surface of the rock, are formed by means of sediment at the bottom of still waters, into which they have been carried. They are much less diffused, less pure, and may contain remains of marine bodies: of this kind are the Œningen formation, a part of the Limagne of Auvergne, and probably the plastic clays and lignites. Lastly, it is to this class that the beds of fresh-water formation belong, which we observe in the *Mollasse* of Switzerland*.

* From the new edition of Cuvier's work on Organic Remains, about to be published.

ART. XVIII.—*On the Methodical and Natural Distribution of the different Systems of Crystallisation.* In a letter from M. WEISS, Professor of Mineralogy in the University of Berlin, to Dr BREWSTER.

SIR,

I HAVE learned from Professor Tralles, that he had conversed with you on the subject of my claims to the methodical and natural distribution of the different systems of crystallization, which has recently been considered in Scotland *, and even in Germany, if we judge from the Annales de Physique of M. Gilbert, as belonging to M. Mohs, but which, in reality, is absolutely mine. Mr Tralles likewise informed me, that you were disposed to repair any injury to my claims, which may have been occasioned by the silence of M. Mohs, in the justly celebrated work, of which he has published two editions in the years 1820 and 1821; and I have, therefore, addressed to you some observations, which I trust you will publish in your valuable Philosophical Journal.

In order to enable you to judge in this matter, it will be sufficient to examine the Table of Mineral Species, distributed according to the method in question, which accompanies a Memoir printed among those of the Physical Class of the Royal Acade-

* When I wrote the two papers, "On the Connection between the Primitive Forms of Crystals, and the number of their Axes of Double Refraction," which were printed in the Memoirs of the Wernerian Society, vol. iii. p. 50. and 357., I was not acquainted with any of the memoirs on crystallography, which had been composed by Professor Weiss; and was, therefore, led to quote only the "Characteristic" of Professor Mohs, which was then publishing in Edinburgh, and which contained a classification of crystalline systems, that harmonised in so extraordinary and unexpected a manner with the optical system which I had previously established. With regard to the extent to which Professor Mohs has been anticipated by Professor Weiss, we cannot at present decide, till we have perused the memoirs of the latter referred to in the following pages; but from what we know of the honour and high character of Professor Mohs, we are convinced that he will be able to give Professor Weiss the most satisfactory explanations on all the points to which he refers. That both these eminent individuals have been carrying on independent inquiries, and advancing greatly the science of crystallography, cannot be questioned; and we do not doubt but that this field of research is sufficiently rich and extensive, to reward the genius and industry of both. D. B.

my of Berlin, for 1814 and 1815, and which is entitled "*Des Divisions Naturelles des Systemes de Cristallisation*, par C. S. Weiss." If there are some parts of this table which require correction, it is only in consequence of more recent discoveries, of which I could not then avail myself.

In reading the memoir itself, you will find in it an explanation, that applies directly to the consideration of different axes, which ought especially to interest and direct the researches of the natural philosopher, of which you have given the most illustrious proofs, in the discovery of the relation between the primitive forms of minerals, and the number of their axes of double refraction, a relation which does not appear to have been conceived or understood by M. Mohs.

In another memoir, published in the subsequent volume of the Memoirs of the Academy of Berlin, for 1816 and 1817, I have explained my method of describing all the crystalline faces of any system whatever, in relation to the fundamental axes of the system, a method which I consider preferable to that of M. Mohs;—and I have also deduced from the polarisation of the *latera* of the crystalline axes, the most curious phenomena of crystallography, such as the reduction to one-half of a number of the co-ordinate faces, &c., a phenomenon which I have expressly described in my memoir of 1815, distinguishing always, in the same general division, those subdivisions which I have called *Homoedriques* (with the number of faces complete), and *Hemiedriques* (with the number of faces reduced to one-half). I have besides pointed out the application of my crystallographic method, to the developement of some particular systems of a difficult nature, such as those of Feldspar and Epidote, which were considered so by Haüy. I might also mention other memoirs, which I have published among those of the Academy of Berlin for 1818, 1819, either on the mathematical theory of crystallonomy, or on topics particularly interesting to natural philosophers; such as the comparison which I have made between the geometrical relations of the dimensions of the principal solids of a regular system, and those of the harmonic intervals in music. Unluckily, however, none of these memoirs have been more fortunate than the first with M. Mohs, to whom I sent them as soon as they were printed, excepting that of 1815, when M.

Mohs was at a distance from his place of residence. You will, no doubt, observe, that, with regard to the foundation of the mathematical properties, what M. Mohs has said of Feldspar is exactly conformable to the views which I had established in 1816; but M. Mohs is silent on this point, and his method of representing the object is in reality his own, and not mine. With respect to Epidote, M. Mohs remarks, in the second edition of his work, when he ought to have been in possession of my memoir on epidote, that this very system was unknown.

It has fallen to my lot, however, to break silence on these matters. You will find in the volume of the Memoirs of the Academy of Berlin for 1820 and 1821, which will presently appear, a new memoir on Sulphate of Lime, and it is there, where, in criticising what M. Mohs has said on this subject, that I have made the reclamation which it was necessary for me to do; and I should have confined it to that memoir, had not the friendship of Professor Tralles led him to give you more immediate and direct information, and engaged me to address this letter to you, —an engagement for which I feel under great obligations to him.

It will readily occur to you, that as I had read to the Royal Academy of Berlin, the memoirs of which I have now spoken, after the year 1815, when I had the honour of being elected a member, it must have been a long time before this that I laid the essential foundation of the system. In the winter of 1812,13, I communicated to my illustrious colleague, M. Von Buch, the outline of the same table which is added to my memoir of 1815. I employed it in my lectures shortly after that time; and, in teaching mineralogy at Berlin, after 1810, I introduced what I had previously done on these subjects.

You are aware that, in 1809, I wrote at Leipsic, where I was then Professor, two Latin dissertations, "*De Indagando Formarum Crystallinarum Charactere geometrico principali*," which were translated into French, by my esteemed and celebrated friend M. Brochant de Villiers, and appeared in detail in the *Journal des Mines* for 1811 *. Whoever was a professed mineralogist, ought to have been acquainted with the existence of these memoirs, the French translation of which was

* Tom xxix. Cah. *Mai* et *Juin*. p. 382.,—387., & 440.

enriched, by the particular friendship of M. Brochant, with Tables and an Index, to facilitate the study of them. I also gave an account of them to your celebrated colleague Professor Jameson. In these memoirs you will find almost all the essential foundations of the actual arrangement which has now risen out of them in a more perfect state. You will find, for example, that I had established the reunion of the systems which have, for their primitive form, a prism with a square base, with those which have the octohedron with a square base, a union which, if I am not mistaken, you have also established optically. In like manner, my respectable friend M. Seebeck found, from his first inquiries into the optical properties of crystals, that they were intimately connected with the differences of the crystalline systems which I had proposed in 1809. In my memoir of 1815, I first abandoned the ideas generally entertained, of the Di-Rhomboedral); the systems of the *Octohedron with a* what is called the Primitive Form. I afterwards, in 1809, subdivided them into four great divisions, separated from one another, viz. the *Regular System*; the *Rhomboedral Systems* (with *square base*, and the systems which I then called the *Octohedron with an elongated rectangle* for their base, of which the two last are evidently the same with the systems improperly called by M. Mohs the *Pyramidal* and the *Prismatic*. I have reduced all these systems to their true source, that is, to the ratio of their principal axes, on which all their properties depend. I perceived, in short, since my dissertations of 1809, that there was in reality no exception to the four general divisions which I had then justly established. For, in 1809, it appeared to me, that *feldspar*, *epidote*, *gypsum*, *axinite*, and *sulphate of copper* could not be referred to them; and, for this reason, I then separated them from all others, in order to treat them apart, which I have since done in an opposite way, but one much more satisfactory.

When M. Mohs came to Freyberg to succeed Werner, I do not suppose that he had then read my memoir of 1815. He had not in reality any other ideas respecting the methodical division of the different systems of crystallization, but those which I had explained in 1809. I know, for example, that M. Mohs, in 1818, still comprehended in his prismatic system, without

any other distinction, what I had called, in 1809, the system having its primitive form an octohedron with an elongated rectangular base; that still later he recognised as natural and good, one of the subdivisions which I had made in 1815 (or rather before 1815), of the same system founded on the general difference of the *homoedral* and *hemiedral* systems, he having given the name of *Hemiprismatic* to the one, leaving the name of *Prismatic* to the others; and, in short, that it was not till 1819–20, precisely when the first edition of his *Characteristic* was published, that M. Mohs recognised another of my subdivisions of the same system, and improperly gave to it the name of *Tetarto-prismatic.*

It would be very agreeable to me to receive an explanation of the silence of M. Mohs; for I esteem him much, and he is a philosopher who does honour to Germany; but my silence ought not to equal his. For any farther remarks, however, on this subject, I shall refer you to my Memoir on Sulphate of Lime, which I have already had the honour of quoting.

The system which is commonly called *Regular* or *Tessular*, I have called also *Sphaeroedral*, on account of its relations with the sphere, which are peculiar to it. It is founded on three axes, perpendicular and equal to each other. I have distinguished, however, the ordinary case, which is *homo-spheroedral*, from the different cases of the system which are *hemispheroedral*, and of which we know that of the pentagonal dodecahedron, which I call the *Pyritoedral* System, and that of the regular tetraedron or *tetra-edral* system (regular); these two cases having quite different laws of the reduction to one-half of the same number of faces to reduce, and of which, I believe that I have shewn the origin in the different manner of being polarised in the *latera* of the three principal axes, in my memoir of 1817, already quoted.

The systems which are founded on three axes perpendicular to each other, two of which are equal and different from the third, may be named, in relation to this same principle, *Bino-singularia*, or Bino-unixal. I had not made a decided subdivision of this general case in 1815, since Harmotome almost alone appeared to me then to give rise to a subdivision into *homoedral* and *hemiedral* systems, analogous to the other gene-

ral cases. I called it then, when taken together, *Viergliedrig* or the *Quaternary System*, an expression which I now restrict rather to the homoedral subdivision which comprehends the systems such as *Zircon*, *Idocrase*, &c. But there is reason now to admit, that there are not only *bino-uniaxal hemiedral* systems, but also others, in a double sense, analogous to the *pyrito-edral* and *tetra-edral* systems, which I shall call, the one *Binoquaternary* (*vier-und-zweigliedrig*), such as *Harmotome* appeared to me to be, and perhaps a part of *Bournonite*, and the other *Quaterno-tetraedral* (*tetraedrisch viergliedrig*), to which I would refer not only *Copper pyrites*, after the observation of M. Mohs, but also *Sulphate of Magnesia*, of which I have crystals too well marked to allow it to be doubted that they belong to this class.

If the measures of the angles of *Wolfram*, are such as they are at present given, this system will form a separate subdivision, which we may call *quaternary tetarto-edral*, or rather *quaternary hemi-et-tetarto-edral*, and which will be analogous to that which is found among the systems belonging to the third general case. It is a long time since I have described it thus; and as I call *vier-und-zweigliedrig* the system of *Harmotome*, I shall call this *vier-zwei-und-eingliedrig*, or *bino-singulo-quaternary*, conformably to the other representative terms which I have adopted.

The third general division is formed by systems with three axes perpendicular to one another, but all unequal. I call these systems *singularia* (*ein-und-einaxig*) I have subdivided this vast division, according as the systems comprehended in it were homoedral or hemiedral, into binary systems, (*zwei-und-zweigliedrig*) *systema binarium*, such as *Topaz*, *Sulphate of Barytes*, &c.; then into *bino-unitary* systems, (*zwei-und-eingliedrig*, *systema bino-singularium*,) such as *Felspar*, *Amphibole*, *Pyroxene*, &c.; and, lastly, into *unitary systems*, (*ein-und-eingliedrig*, *systema singularium*), such as *Axinite and Sulphate of Copper*. These last containing the fourth, that is, the half of the half of an entire number of faces co-ordinate to one another, are justly called by their more theoretical name, *uni-axal tetarto-edral systems*, instead of *tetarto-prismatic* systems, as they are called by M. Mohs. We shall also designate by the more the-

oretical names, ***systemata singulaxia homoedrica***, and ***singulaxia hemiedrica***, the two first subdivisions of the general case, which comprehend the *systemata singulaxia.*

You are aware that we do not yet know by observation, the tetartoedral system as a subdivision of the spheroedral one, and that it is only by abstraction that M. Mohs and I have treated of the solid *tetarto-edre spheroïdal*, or *solidum-tetarto-spheroedricum.* I have done this in my Memoir of 1815, in relation to a third case of the *hemispheroedral* system, which is possible, also, or geometrically admissible, and of which I have described the general form, under the name of *Leucitoides tournées* (gedrehte Leucitoide,) or *solidum Leucitoides detortum.* I have since found for them a still more expressive name, viz. *grenatdysedre*, since we may consider them as *Rhomboidal* or *Grenatoedral Dodecaedrons*, having a bevel on each face. I have pointed out in my memoir of 1815, the interesting difference of these solids, to be turned to the right or to the left, which gives always solids opposite or different, and similar to one another in opposite directions. I have likewise pointed out the reality of these opposite solids among crystals, and their frequent occurrence even, in a Memoir on the most ordinary double crystals of Felspar, viz. those of Carlsbad, inserted in the *Neues Journal der Chimie und Physik* de M. Schweigger, tom. xi.

There now remain only those systems which are not founded on three axes only, like all the preceding, but on the relation between a principal axis and three others equal and perpendicular to one another and to the first, and, consequently, forming always with each other an angle of 60°. This case will be called in general, *Systeme terno-singulare.* It contains, as you know, two great subdivisions, viz. the *homoedral* and the *hemiedral.* The first is what I call *sechsgliedrig*, or *systema senarium;* as, for example, *Quartz*, in its ordinary form, then *Beryl*, *Apatite*, &c. The second form is the *Rhomboedral System*, which, by analogy with the preceding, I call *drei-und-dreigliedrig*, or *systema ternarium.* It would be useless to adduce examples so well known as *carbonate of lime*, &c. There certainly, however, exist other subdivisions, to make this fourth case general. *Quartz* itself forms one of them, which is, in reality, hemiedral, but in another sense, and after a quite different law, from the Rhomboe-

drons. It might be called *gewerdet-sechsgliedrig*, or *systema senario-hemiedricum detortum*. which will possess the remarkable property, that its solids will be turned sometimes to the right and sometimes to the left, as I have fully explained in a Memoir on the Crystalline System of *Quartz*, which I have inserted among the *Memoires de la Société des Amis Scrutateurs de la Nature de Berlin;* a property, besides, of which I have endeavoured to demonstrate the physical principle, in the way of its being polarised in the *latera* of the axes of this system, in the Memoirs of the Royal Academy of Berlin for 1817.

But it is not *Quartz* alone which requires new subdivisions to distinguish it, in our fourth general case. *Tourmaline* presents another example, having some analogy with the *tetarto-edral* systems of the other principal divisions. I shall not, however, detain you any longer on this subject. In making a comparison of my terms with those of M. Mohs, you will, I am persuaded, prefer mine to his, which appear to be too inconvenient to be substituted in their place; particularly as mine were formed and published several years before those of M. Mohs. I confidently hope that you will find my method the most simple, and the most natural, of any that we possess; and I may even go so far as to say with strictness, that, in many points, my method is not susceptible of farther simplification. I am, &c.

GOTTINGEN, October 3. 1822. WEISS.

ART. XIX.—*On the Revolutions which have taken place in the Animal Kingdom, as these are indicated by Geognosy.* By Dr FLEMING *.

THE organic remains of the animal kingdom, found in the strata of this country, are generally supposed to bear a very close resemblance to the living races which inhabit the warmer regions of the earth, and to be unlike the modern productions of temperate and cold climates. In the firm belief of the truth of

* Abridged from his "Philosophy of Zoology," vol.

this statement, many naturalists have concluded, either that these organic remains must have been brought into their present situation, by some violent means, from tropical regions, or that our country once enjoyed the warmth of a tropical climate. The tenderness and unbroken state of the parts of these remains, and a variety of circumstances connected with their position, intimate the absurdity of the first supposition, and the truths of astronomy give ample discouragement to the latter. It would have been wiser to have examined all the conditions of the problem before attempting its solution, than rashly suffer the imagination to indulge in speculation and conjecture. Had this examination taken place, we venture to assert that the conclusion, that fossil shells, and other relics, must have been, while recent, the natives of a warm country, would never have been announced as an article of the creed of any geologist.

As the opinion here advanced is very different from that which is received by some authors, it seems necessary, before giving the proofs of its truth, to trace those circumstances which have operated in leading into error.

The shells and corals which are found in a fossil state, have probably been quoted more frequently, as proofs of the truth of the popular opinion on the subject, than any other class of relics. Now, here it may be observed, that for upwards of two centuries past, collections of tropical shells and corals have been forming in this country, and on the continent of Europe. During this period the native productions have been examined and collected by few. It therefore happened, that the tropical testacea and zoophytes, were better known than those of temperate regions. An observer, finding a fossil shell or coral, had it not in his power to compare them with the productions of his country, in public collections, or in the descriptions and engravings of books on natural history. He could compare them with the figures or specimens of foreign species only, and if he discovered an agreement in the external appearance of a species, or even a genus, might be led to conclude, that he had found a tropical shell or coral in a fossil state in Great Britain. A few hasty examinations of this kind, in which remote analogies were suffered to be considered as proofs of identity, and the indications of a *genus* mistaken for the marks of a *species*, could not fail to lead the

mind to erroneous results. With the progress of science, however, the geographical limits of species and of genera, have been more carefully investigated, collections of native productions have become more numerous and accessible, and the sources of error greatly diminished. It is perhaps necessary to add, that among all those who have attempted to investigate the history of fossil species, there have been very few at the same time acquainted with the characters of recent animals, and with the details of geognosy. When all these circumstances are duly considered, it need not appear surprising, that the results hitherto obtained are so inconclusive, or rather so distant from the truth.

It may be stated, in opposition to the opinion against which I am contending, that, in general, *there are existing species in this country, belonging to the same genera or natural families, as those which are found imbedded in the strata of the earth in a fossil state*. The Nautilus (of Lin., including those which are spiral, and the straight Orthocera), for example, is found in the oldest and the newest rocks containing petrifactions. Several species from the tropical seas occur in our public collections. But it is not generally known, that, by the labours of Boys, Walker and Montagu, nearly thirty different species have been detected in a recent state, on our own shores. It is true, that the recent tropical kinds are larger than our indigenous species, and in this character they resemble the fossil species. But this circumstance is of no weight, when considering the geographical distribution of *different* species or genera. The Anomia (Lin.), common in a fossil state, are also represented by many recent kinds in our seas, and the same remark is applicable to the Madreporæ, and Milleporæ.

It may here be said, that the remains of animals which do not now live in temperate regions, as the Elephant, Rhinoceros, and Tapir, are found in a fossil state in such districts. This objection, however, is of no great weight, and derives its principal support from the prejudices associated with the appellations of the species now noticed. When the name Elephant is pronounced in our hearing, the imagination immediately presents us with the picture of an animal browsing in an equatorial forest, guided by a Lascar, or hunted by a Caffre. We are so impatient to speculate, that we do not stop to inquire, whether

the bones found in a fossil state belong to the living *species*, or to a member of the same *genus* only, now extinct. Although the lovers of hypothesis have rejected this inquiry as useless, others have submitted to the labour of the investigation. It was ascertained at an early period, by several observers, that many of the large bones dug up from the alluvial soil, in the temperate and cold regions of Europe, Asia, and America, belonged to a species of the genus Elephas; but it was reserved for Camper, Hunter, and Cuvier, to demonstrate, by means of the characters furnished by the bones of the head and the teeth, that these fossil remains belonged to *a species of elephant, different from any of those now living, or known to exist on the globe*. When the specific difference of the fossil species, denominated by the Russians Mammoth, had been determined, it became unsafe to speculate about the climate under which it had subsisted, since *each species of a natural genus is influenced in its geographical and physical distribution, by peculiar laws*.

Raspe, from an examination of the soil in which the bones were imbedded, and the different countries in which they had been discovered, without the aid of comparative anatomy, arrived at the conclusion, that the elephant, to which these relics belonged, may have been *a native of northern countries*, in which it had lived, propagated, and expired. This important conclusion, which has since been extended to other fossil species, received abundant confirmation, by the fortunate discovery, in 1799, of an entire carcase of this northern elephant, preserved in the ice, at the mouth of the Lena, on its entrance into the Frozen Ocean. The animal had been in good condition at its death, and its flesh was in such perfect preservation, that the Takutski, in the neighbourhood, cut off pieces to feed their dogs with; and the white bears, wolves, wolverines, and foxes, made likewise an agreeable repast. But the most interesting circumstance connected with this individual, was its covering of hair. The elephant, and indeed all tropical animals, as formerly stated, are thinly covered with short hair. This Siberian animal, on the other hand, was thickly covered with long hair. Upwards of thirty-six pounds of the hair were collected: the greater part of which

the bears had trod into the ground, while devouring the flesh. Much of the original quantity, therefore, was lost. This quantity of hair indicated not a native of a tropical climate, but an inhabitant of a cold region. Its characters served to remove all doubt upon the subject. It consisted of three kinds;—bristles, nearly black, much thicker than horse hair, and from twelve to eighteen inches in length; hairs of a reddish-brown colour, about four inches in length; and wool of the same colour as the hair, but only about an inch and a half long. These circumstances demonstrate, that this *species* of elephant was suited to reside in the temperate and cold regions, in which its bones are at present discovered, *and that the climate of Siberia, at the time when the mammoth flourished, was the same in temperature, or nearly so, as it is at present.* These facts, viewed in connection with others equally striking with regard to the fossil rhinoceros, indicate the impropriety of speculating about the origin of fossil animals, without having previously determined the *species*, or attended to the laws which regulate the distribution of the existing races.

While there are many genera, containing both extinct and recent species, there are other genera, which have no living examples, as Belemnites, Mastodon, Anoplotherium, and Palæotherium. These facts seem to indicate a former condition of the Earth's surface, very different from that which prevails at present in any latitude.

It has frequently been remarked by British and Continental writers, that in the same quarry, or mine, the organic remains contained in one bed often differ from those in the contiguous beds, and that the same bed, in its course through several miles, may be easily recognised by its petrifactions. Werner, in attempting to generalise this observation, announced it as his opinion, "That different formations can be discriminated by the petrifactions they contain." When it is considered that a particular bed of rock can seldom be traced for many miles, the assertion that it may, through this extent, be characterised by its petrifactions, is neither in opposition to observation, nor the laws which regulate the distribution of animals. But when it is meant to be understood, that the same group, or formation of beds, (though occupying the same position with respect to other

groups) however remotely connected in geographical position, contain the same petrifactions, it becomes necessary to state, that such an opinion is unsupported by observation, and inconsistent with the laws which *at present* influence the distribution of animals. There is no proof of the same fossil *species* being found in the same formation at the equator, and in temperate and cold regions; and when *genera* only are referred to, the reasoning becomes exceedingly vague, and apt to mislead. The celebrated Von Buch, a pupil of Werner, in his Travels through Norway, gives us an example of the Wernerian rule, by stating, that Orthoceratites characterise exclusively the transition limestone formation. There is, however, no evidence, that the *species* of Orthoceratites were here considered, nor that those which occur in the transition limestones of Norway, Germany, and Ireland, have been investigated with the view of determining the particular species: and I have demonstrated that the rule does not hold true, in reference to the *genus*, by the publication of figures and descriptions of ten species of Orthoceratites, from the beds of the independent coal formation. Until geologists form more accurate notions with regard to fossil *species*, no reliance can be placed on the observations which they offer respecting their geographical distribution.

We have no reason to doubt, that the laws which now regulate the geographical distribution of animals and plants, did exercise their influence at the period when the transition and flœtz-rocks were forming. We may, accordingly, expect to find the *fossil* animals and plants of the temperate regions, differing as much from those in tropical countries, as the recent kinds are known to do. Each region may be expected to exhibit a peculiar fossil Fauna and Flora.

In reference to this view of the subject, we may add, that the laws which regulate the distribution of recent animals, have been, in a great measure, deduced from observations on those which inhabit the countries between the Tropic of Cancer and the Arctic Circle; so that we have much to learn with regard to the characters of those which dwell between the Antarctic Circle and the Tropic of Capricorn. But the observations on the distribution of the fossil species, from having been chiefly carried on in the middle and south of Europe, are more con-

fined. A vast number of fossil species, therefore, remain unexplored in the equatorial and antarctic regions, the characters of which will either confirm the view which is here given, or furnish evidence for that alteration of climate, occasioned by a change in the obliquity of the ecliptic, or in the Earth's axis of rotation, which a few naturalists believe to have taken place. If the fossil animals at the Equator do not resemble recent or fossil Arctic productions, but exhibit characters peculiar to themselves, it will be necessary to abandon the idea of great astronomical revolutions, and content ourselves with investigating the changes organised beings are experiencing at present, in order to discover those circumstances which have impressed on the fossil species their peculiar outlandish character.

3. The opinion entertained by Werner, that the petrifactions of the older rocks belong to animals of more simple structure and less perfect organisation, than those which occur in the recent deposits, is, when considered in a very general point of view, an approximation to the truth. In the beds of the transition class (the oldest rocks which are known to contain petrifactions), the remains both of radiate and molluscous animals occur; yet the organisation of the latter is considered more perfect than that of the former. In the transition class, however, no remains of vertebrose animals have been detected. In the independent coal-formation (one of the oldest groups of the flœtz-class), in addition to the relics of radiate and molluscous animals, those of several annulose animals occur, as species of the genera Trilobites, Dentalium and Spirorbis; together with fishes, both osseous and cartilaginous. In the newer groups of the flœtz series, relicts of amphibia make their appearance, and in the newest groups those of birds and quadrupeds. In the oldest alluvial deposits are found the bones of extinct quadrupeds; in the newer beds, those of such as still survive. From the period, therefore, at which petrifactions appear in the oldest rocks, to the newest formed strata, the remains of the more perfect animals increase in number and variety; and it is equally certain, that the newest formed petrifactions bear a nearer resemblance to the existing races, than those which occur in the ancient strata. The older remains are much altered in their texture, and more or less incorporated with the matter of the rock,

while the newer are but little altered. These circumstances lead us to believe, that the strata containing petrifactions were once in a state of *mud;* and that the same process which altered the imbedded relics, communicated to the surrounding matter its present compact or crystalline structure.

These facts in the history of animals, which have been ascertained by the researches of the geologist, lead the inquisitive mind to investigate those circumstances which have operated in bringing about such mighty revolutions. In conducting the inquiry, it is necessary to impose restraint upon the imagination, and deliberately to examine the existing causes of change in the animal kingdom, in order to comprehend the alterations which have already taken place, or to anticipate those which may yet be produced. What influence has man exerted in producing such changes?

The situation in which we are placed in this world, renders it necessary for us to attempt the destruction of many races of carnivorous animals, to drive them from our dwellings, cut them off in their retreats, and prevent them from living in the same region along with us. When we begin to keep flocks of tamed animals, to plant gardens and sow fields, we expose ourselves to the inroads of a greater number of depredators, and consequently wage more extensive war. The war waged, in the early stages of society, against various animals, is a measure of security. With the progress of civilization this war becomes an amusement; and in the absence of those animals really destructive to our interests, we make sport of the death of others which are inoffensive. But the employment of the chace is not altogether a measure of safety or amusement. We hunt to obtain food and clothing, and a variety of ornamental and useful articles of life.

The havock which man thus commits in the animal kingdom, has occasioned the extirpation of many species from those countries of which they were formerly the natural possessors. In this island, since the Roman invasion, some species of quadrupeds and birds have disappeared; and others are becoming every year less numerous. Of those which have been extirpated, the bear and the beaver, the crane and the capercailzie, may be quoted as well known examples. The same changes are taking

place in every cultivated region of the earth, each having, within the very limited period of history or tradition, lost many of the original inhabitants.

When it is considered, that the business of the chace has ever been keenly followed by man, from the first stages of society to the present day; that its triumphs have been eagerly sought after, and highly prized; and when these circumstances are united, with the recollection of the numbers of the human race dispersed over the globe, all prosecuting the same purpose, for the long period of nearly 6000 years, it does not appear unreasonable to conclude, that man has effected many changes in the geographical distribution of animals. Perhaps he may have succeeded, in the course of this long period of persecution, in completing the destruction of several species, the memorial of which tradition has failed to preserve, while their remains may yet be traced in the newer and perhaps older alluvial deposits.

However great those changes may have been, in the condition of certain species, brought about by human agency, there are many other revolutions which have taken place in the animal kingdom, over which man could exercise no control. Many corals and shells, the bones of fish, reptiles and quadrupeds, are imbedded in stone, which have belonged to species which do not now exist in a living state on the globe, and which, probably, were extinct before man exercised any control. By what cause, then, have these revolutions been effected?

When we attend to the physical conditions of temperature, food, situation, and foes, which must at all times have exercised their influence over the existence and geographical distribution of animals, it will appear obvious, that a variety of causes (a change in one or all of these conditions) may have operated in promoting the increase of some species, and in producing the decay or extinction of others. Have we, then, any proof of such changes in the truths of geognosy, or in the alterations which we witness taking place on the surface of the globe?

When we look at a river after rain, emptying its contents into the sea, we perceive that it has brought along with it a considerable quantity of gravel and mud, which it deposits in the form of bars, sand-banks, or deltas. This mud has been obtained from the disintegration and wearing down of the rocks

through which it has passed; and contributes to fill up the ocean, by forming land on its borders. The flat ground at the mouth of the Ganges, the Nile, and the Rhine, have derived their origin from this source, as well as the *carses* of Falkirk and Gowrie, in Scotland. If the attention is turned from the sea to inland lakes, we observe the same process of *upfilling* going on, with the assistance of other circumstances connected with their condition. Mud is constantly poured into them by the rivulets; the testaceous animals separate lime from the water, for their shells, which ultimately go to the formation of marl. Aquatic plants multiply; and, by their annual decay, form layers of peat. The whole mass of foreign matter, by degrees, acquires the altitude of the mouth of the lake, passes into the state of a marsh; and, by the wearing away of the rocks at the outlet, is in part drained, becomes fit for grazing, and, finally, suitable for cultivation. The rivulets, now prevented from precipitating their suspended contents in the lake, carry them to some lower pool, or farther on to the sea. Numerous plains, meadows, and peat-bogs, indicate the former operations of this process; and, in every lake at present, similar changes may be observed taking place.

This obvious tendency of the present order of things, to wear down eminences, and fill up hollows, has not been confined to the period of the formation of the alluvial strata, but has exerted its influence during the period of the formation of all those rocks in which organic remains are imbedded. Thus, when the position of the beds of the transition rocks are examined in the great scale, they are found to occupy immense hollows in the primitive rocks. The old red sandstone fills up the hollows of the transition, and occasionally of the primitive rocks. The independent coal formation is found occupying the hollows of the preceding groups. The hollows of these different formations have been still farther filled up, by the numerous series of beds connected with chalk and gypsum; and, at last, we come to the alluvial deposits, which at present are contributing to fill up existing inequalities.

These changes which have taken place, have every where diminished the height of mountains, filled up lakes, and increased the quantity of dry land. We may therefore safely draw the

conclusion, that, along with the increase of dry land, there must have been a proportional diminution of aquatic animals and plants, and a corresponding increase of those which inhabit the land. There is likewise reason to conclude, that, amidst these vast revolutions, so many alterations must have taken place in those physical conditions, on which the life of animals depends, that multitudes must have been annihilated with every successive change. The increase of land, by this process of upfilling, and the reduction of the number of mountains supporting glaciers, must have altered greatly the temperature of the globe; and, in every region, increased the difference between the heat of summer, and the cold of winter, by promoting the intensity of each. This change of temperature may have been somewhat modified by the progress of *vegetation* in the different periods, by the formation of volcanic land, and the heat communicated to the air by volcanic fire. It is impossible to estimate all the effects which these changes may have produced on different species of animals, but little doubt need be entertained that they were of considerable extent.

In consequence of these changes which have taken place on the earth's surface, corresponding alterations must have been produced in its condition, as a residence for animals. Every lake, as it was filled up, would receive the remains of all those of its inhabitants, the locomotive powers of which prevented them from shifting to a more suitable dwelling. If a number of these lakes were filled up nearly at the same time, over the whole, or a large portion of the globe (and the universality of many of these upfilling formations justify the supposition), the total extinction of a race of animals may have taken place; and each succeeding deposition may have been equally fatal to the surviving tribes.

If every physical change which can take place on the surface of the earth, whether it be an alteration of temperature, of the quantity of land or water, of moisture or dryness, is detrimental to some animals, we need not be surprised, that, amidst the vast number which has occurred, many species have disappeared, whole races become extinct, and the general features of the animal kingdom undergone successive changes.

When we trace the characters of the different depositions which have taken place, from the newest alluvial beds, to the

oldest transition rocks containing petrifactions, we witness very remarkable gradations of character. The newest formed strata are loose in their texture, and usually horizontal in their position. In proportion as we retire from these, towards the older formations, the texture becomes more compact and crystalline, and the strata become more inclined and distorted. These characters may be traced, by comparing the common loose marl of a peat-bog with the firmer chalk; the compact floetz limestone with the transition marble; or the peat itself with the older beds of wood-coal, or the still older beds of coal of the independent coal formation. The organic remains in the newer strata are yet unaltered in their texture, and easily separable from the matter in which they are imbedded. In the older rocks, the remains are changed into stone, and intimately incorporated with the surrounding rocks. These facts are of vast importance, in a geological point of view, as they make us acquainted with the original condition of the matter with which the organic remains were enveloped, and lead us to believe that the bed now in the form of limestone or marble, was once loose as chalk, or even marl; that coal once resembled peat; and that the strata of sandstone and quartz rock were once layers of sand. They are no less interesting when viewed in connection with the characters presented by the petrifactions of the different æras.

The fossil remains of the alluvial strata, nearly resemble the same parts of the animals which live on the earth at present; and, in the newer strata, the remains of existing races are found. As we trace, however, the characters of the petrifactions of the flœtz and transition rocks, we find the forms which they exhibit, differing more and more from the animals of the present day, in proportion as the rocks in which they are contained exhibit new characters of texture, position, and relation.

It is impossible to regard these concomitant circumstances as accidental. Their co-existence indicates the relation, and leads to the conclusion, that the revolutions which have taken place in the animal kingdom have been produced by the changes which accompanied the successive depositions of the strata. According to this view of the matter, the animals and vegetables with which the earth is peopled at present, could not have lived at the period when the transition rocks were forming. A variety

of changes have taken place in succession, giving to the earth its present character, and fitting it for the residence of its present inhabitants. And if the same system of change continues to operate (and it must do so while gravitation prevails), the earth may become an unfit dwelling for the present tribes, and revolutions may take place, as extensive as those which living beings have already experienced.

In addition to these circumstances, which must have exercised a powerful influence on the distribution of animals, we must bear in mind, that the universal deluge of NOAH, and the numerous local inundations, the traces of which may be perceived in every country, must have greatly contributed to produce changes in the animal and vegetable kingdom. To these inundations may be ascribed the occurrence of the remains of supposed land plants, and fresh-water animals in strata, alternating with such as contain only marine exuviæ. These appearances occur in the secondary formations of all ages.

ART. XX.—*On the Theoretical Principles of the Machinery for Calculating Tables* *. In a Letter from CHARLES BABBAGE, Esq. F. R. S. Lond. & Edin. to Dr BREWSTER.

MY DEAR SIR,

HAVING, during the last two or three months, laid aside the further construction of machinery for calculating tables, I have occasionally employed myself in examining the theoretical principles on which it is founded. Several singular results having presented themselves in these inquiries, I am induced to communicate some of them to you, less from the importance of the analytical difficulties they present, than from the curious fact which they offer in the history of invention.

I had mentioned to you, that, before I left London, I had completed a small engine, which calculated tables by means of differences. On considering this machine, a new arrangement occurred to me, by which an engine might be constructed, that

* See this *Journal*, Vol. VII. p. 274.

should calculate tables of other species, whose analytical laws were unknown. On this suggestion, I proceeded to write down a table which might have been made, had such an engine existed; and finding that there were no known methods of expressing its *n*th term, I thought the analytical difficulty which was thus brought to light, was itself worthy of examination. The following are the first thirty terms of a series of this kind:

0... 2	11...222	22...924
1... 2	264	1010
2... 4	310	1096
3... 10	356	25...1188
4... 16	15...408	1288
5... 28	468	1396
48	536	1510
76	610	1624
110	684	30...1742
144	20...762	1862
10...182	842	1984

The law of formation of which is, that the first term is 2, its first difference 2, and its second difference equal to the units figure of the second term; and generally, the second difference corresponding to any term, is always equal to the units figure of the next succeeding term. This engine, when once set, would continue to produce term after term of this series without end, and without any alteration; but we are not in possession of methods of determining its *n*th term, without passing through all the previous ones. If u_n represent any term, then u_n must be determined from the equation

$$\Delta^2 u_n = \text{the units figure of } u_{n+1}\,;$$

an equation of differences of a species which I have never met with in treatises on that subject.

If we push the inquiry one step farther, it is possible to express the units figure of any number in an analytical form. Thus, let S_v represent the sum of the *v*th powers of the tenth roots of unity, then will

$$0\,S_{v} + 9\,S_{v+1} + 8\,S_{v+2} + \ldots \qquad 1\,S_{v+9}$$

represent the units figure of the number v. Now, if we put u_{n+1} instead of v in the above equation, we have

$$\Delta^2 u_n = 0\,S_{u_{n+1}} + 9\,S_{u_{n+1}+1} + 8\,S_{u_{n+1}+2} + \ldots \qquad 1\,S_{u_{n+1}+9}$$

an equation whose mode of solution is as yet quite unknown. Finding the difficulty of a direct attempt so considerable, I employed two other processes; one was a kind of induction, and the other was quite unexceptionable. From these I have deduced the following formula:

$$u_n + \overline{(a)} + 20b\,(10b + 2a - 1) + 2,$$

where a is the units figure of n; b is the number n, when its unit figure is cut off; and $\overline{(a)}$ represents whatever number is opposite to it in the subsidiary table below:

If $a = 0\ldots$	0
$1\ldots$	0
$2\ldots$	2
$3\ldots$	8
$4\ldots$	14
$5\ldots$	26
$6\ldots$	46
$7\ldots$	74
$8\ldots$	108
$9\ldots$	142

EXAMPLE: Required the 27th term of the series here, $a = 7$, and $b = 2$: hence,
$10b + 2a - 1 = 20 + 14 - 1 = 33.$

then

$\overline{(a)}$ or the number opposite 7, is -	74
$20b\,(10b + 2a - 1) =$	1320
$2 =$	2
	$1396 = u_{27}$, or the 27th term

similarly if $\quad n = 1121 \quad a = 1 \quad b = 112$

then $\quad u_{1121} = 251106.$

Another series of a similar kind, but more simple in its form, is derived from the following equation:

$$\Delta u_z = \text{units figure of } u_z$$

If the constant or first term is equal to 2, then we may express u_z thus,

$$u_z = 20\,b + 2^a,$$

where a is any of the numbers 1, 2, 3, 4, which, taken from z, leaves the remainder divisible by 4, and b is the quotient of that division: the series is,

1... 2	48	EXAMPLE: Let $z = 13$
4	56	1 being subtracted, 1
8	62	—
16	64	12 which,
5...22	15...68	divided by 4, gives 3, hence,
24	76	$a = 1$ $b = 3$
28	82	$u_{13} = 20.3 + 2 = 62.$
36	84	
42	88	
10...44	20...96	

Innumerable other series might be formed by the same engine, the differences of any order depending on the value of the figure which might occur in the units, or the tens, or the hundreds place, or in any one or more determinate places of the same, or the next, or preceding terms. Other laws might be observed by the same engine, of which the following is an example. A series of cube numbers might be formed, subject to this condition, that whenever the number 2 occurred in the tens' place, that and all the succeeding cubes should be increased by ten. In such a series, of course, the second figure would never be a 2, because the addition of ten would convert it into 3.

The Series of Cubes.	The Series Proposed.
1	1
8	8
27	* 37
64	74
125	135
216	* 236
343	363
512	532
729	749
1000	* 1030
1331	1361
1728	1758
2197	* 2237
2744	2784

the stars indicating the number at which the law takes effect. These, and other similar series, open a wide field of analytical inquiry,—a subject which I shall take some other opportunity of resuming. I will, however, mention an unexpected circumstance, as it illustrates, in a striking manner, the connection between remote inquiries in mathematics, and as it may furnish a lesson to those who are rashly inclined to undervalue the more recondite speculations of pure analysis, from an erroneous idea of their inapplicability to practical matters. Amongst the singular and difficult equations of finite differences to which these series led, I recognised one which I had several years since met with, in an analytical attempt to solve a problem considered by Euler and Vandermonde; it relates to the knight's move at chess. At that time, I had advanced several steps; but the equation in question proved an obstacle I was then unable to surmount. In its present shape, although I have not yet deduced the solution from the equation, yet, as I am in possession of the former, it is not too much to anticipate a general process applicable to this class of equations; and should that be the case, I shall be able to advance some steps farther in a very curious and difficult inquiry, connected with the geometry of situation.

As an erroneous idea has been entertained relative to the nature of the machinery I have contrived, I will endeavour to state

to you some of the mathematical principles on which it is founded. The contrivances of Pascal and others have, as far as I am aware, been directed to an entirely different object. Machinery which will perform the usual operations of common arithmetic, will never, in my opinion, be of that essential utility which must arise from an engine that calculates tables; and although mine is not defective in these points, and will extract the roots of numbers, and approximate to the roots of equations, and even, as I believe, to their impossible roots, yet, had this been its only office, I should have esteemed it of comparatively but little value. As far as I have inquired, I believe the method of differences has now, for the first time, been embodied into machinery; and in speaking of this method, I am far from meaning to confine myself to calculating tables by constant differences. The same mechanical principles which I have already proved, enable me to integrate innumerable equations of finite differences, if I may be allowed to use the term *integrate*, in a sense somewhat different from its usual acceptation. My meaning is, that the equation of differences being given, I can, by setting an engine, produce, at the end of a given time, any distant term which may be required; or, if a succession of terms are sought, commencing at a distant point, these shall be produced. Thus, although I do not determine the analytical law, I can produce the numerical result which it is the object of that law to give. Some kinds of equation of differences, can be adapted to machinery with much greater facility than others; and hence it will become an object of inquiry, how, when we wish to calculate that of any transcendant, we may deduce from some approximate equation the differences which may be suitable to our purpose. Thus, you see, one of the first effects of machinery adapted to numbers, has been to lead us to surmount new difficulties in analysis; and should it be carried to perfection, some of the most abstract parts of mathematical science will be called into practical utility, to facilitate the formation of tables. The more I examine this theoretical part, the more I feel convinced that it will be long before the novel relations which it presents will be exhausted; and if the absence of all encouragement to proceed with the mechanism I have contrived, shall prove that I have anticipated too far the period at which it shall become necessary, I will yet ven-

ture to predict, that a time will arrive, when the accumulating labour which arises from the arithmetical applications of mathematical formulæ, acting as a constantly retarding force, shall ultimately impede the useful progress of the science, unless this or some equivalent method is devised for relieving it from the overwhelming incumbrance of numerical detail. I remain,

My Dear Sir,

Faithfully yours,

C. BABBAGE.

DEVONSHIRE STREET,
PORTLAND PLACE,
6th Nov. 1822.

ART. XXI.—*Account of* MR BARTON'S *Method of making the Iris Metal ornaments, or of ornamenting Steel, and other Metals, with the Prismatic Colours.*

THE production of the prismatic tints, by scratches upon the surfaces of metallic and transparent bodies, was first observed by the celebrated Boyle. They were particularly studied by Mazcas and Mr Brougham; and Dr Thomas Young afterwards examined them with particular care, and ranked them in the class of optical phenomena, known by the name of the "Colours of striated Surfaces."

Dr Young's experiments were made on the prismatic colours displayed in Mr Coventry's micrometers, consisting of parallel lines drawn upon glass, at the distance of $\frac{1}{500}$th of an inch. Each of these lines he found to consist of two or more finer lines, at the distance of somewhat more than $\frac{1}{20}$th of that of the adjacent lines. Dr Young ascribes these colours to the interference of two portions of light, the one reflected from one side of the groove, and the other portion from the other side; and he concludes, that there is a striking analogy between this separation of colours, and the production of a musical note, by successive echoes from equidistant iron palisades.

This class of colours was afterwards investigated by Dr Brewster, as exhibited in *Mother-of-Pearl,* and in various other ways. He found, by the aid of the microscope, that they arose from grooves in its surface; that they were produced when the flat

surface was unpolished, and that they could be communicated to wax, gum-arabic, tinfoil, the fusible metal, and even to lead, by hard pressure, or the blow of a hammer. He determined also, that the mottled colours upon all bodies with an imperfect polish, and the scratches or grooves upon polished metals, could be communicated to wax, and other substances *.

The same structure which gives these communicable colours, he succeeded in producing artificially on the surface of calves-feet jelly, that had been boiled for a considerable time. This surface was covered with corrugations; but totally unconnected with these corrugations, he discovered, with a powerful microscope, the same minute grooves which exist in mother-of-pearl, and they were so near one another, that some thousands of them must have been contained in a single inch. These grooves were completely invisible to the unassisted eye, but they gave in a very distinct manner, the colours of mother of-pearl.

Mr Barton, of the Mint, a gentleman well known for his ingenuity and his mechanical attainments, has recently conceived the happy idea of ornamenting steel, and other articles, with the colours of striated surfaces, and has secured, by patent, the exclusive privilege of applying this principle to practical purposes. The excellence of Mr Barton's engine has, no doubt, enabled him to execute this kind of work, with a beauty and precision which no other person can hope to imitate. The engine which he uses was given to him by his father-in-law, the late celebrated Mr Harrison. It was constructed by Mr Harrison himself, and its merits depend chiefly on the beauty and correctness of the screw; the apparatus for cutting which, by an excellent inclined plane, also accompanied the engine. The plate in the screw is not divided higher than the 2000dth part of an inch; but Mr Barton has drawn divisions on steel and glass so minute as the 10,000dth part of an inch. In drawing lines of 2000

* Dr Brewster also succeeded *in communicating the colours from one piece of wax to another piece of wax*, and from this *second* piece to a *third* piece. By a little precaution, a sunk impression may, upon the same principle, be taken from a wax seal, upon another piece of wax; and this may be used, for a long time, to give impressions nearly as distinct as the original seal. If the piece of wax to be used is hardened with lac, it will last still longer.

in an inch, Mr Barton often leaves out *one line* intentionally; and one of the greatest proofs of the stability of the engine is, that after having taken off the brass table, with the work upon it, (when the omission is distinctly perceived), *he can restore it to its place, and introduce the line, without its being distinguishable from the rest.*

In applying the principle of striated colours to ornament steel, the effect or pattern is produced upon the polished surface, by the point of a diamond, so that either the whole, or a part of the surface, is covered with lines or grooves, whose distance may vary from the 1000th to the 10,000th of an inch. When these lines are *most distant*, the prismatic images of the candle, or any luminous body, seen by reflection from the polished surface, are *nearest* one another and the common colourless image; and when the lines are *least distant*, the coloured images are *farthest* from one another, and the colours are most vivid.

In day-light, the colours produced by these minute grooves are scarcely distinguishable, unless at the boundary between a dark and a luminous object; and we conceive that their brilliancy will be very much impaired, even with artificial lights, when they are dispersed by the interposition of globes or hemispheres of ground glass.

In sharp lights, however, and particularly in that of the sun, the colours shine with extraordinary brilliancy, and the play of tints which accompany every luminous image, can only be equalled by their matchless exhibition in the reflections of the diamond. The surface of fine steel, therefore, when grooved by such a skilful hand as Mr Barton's, is peculiarly fitted for imitative jewels, and other articles of female dress; and we have no doubt, that it will find an application to many other purposes, both of use and ornament.

The divisions which Mr Barton most commonly uses for his metal ornaments are 2000 to an inch; but when the material is good, his engine enables him to divide to 5000 and 10,000. When the lines, however, are so close, the labour is very great; but the beauty of the work is generally a compensation for the time bestowed upon it, as the strength of the colours increases with the number of lines. The depth of the line, Mr Barton finds to have a great effect in producing brilliancy, owing to the

increase in the quantity of reflected light; and he is, in some measure, enabled to judge of the depth, by the faintness of the reflected image of his eye, when looking perpendicularly at the steel; until, at last, by totally removing the original surface, in consequence of the edges of the cut meeting, the whole surface looks black, and the eye is no longer seen.

SINCE the preceding notice was written, Mr Barton has had the kindness to favour us with various specimens of the ornaments executed by his engine, and high as our expectations were, we confess they were greatly surpassed by the work itself.

Some of the specimens are struck from steel dies, containing the grooved pattern, and it is singular to observe the perfection with which the impress of such delicate work has been conveyed.

In one of the patterns on polished steel, a spiral line, beginning at the centre, advances to the circumference of a circle, about $\frac{3}{4}$ths of an inch in diameter, each coil of the spiral keeping at the distance of about $\frac{1}{970}$th of an inch from the one adjacent to it. When the eye, held close to this specimen, views a lighted candle reflected from the grooved surface, it appears surrounded with a series of the most brilliant concentric rings of coloured light, passing into a sort of tinted radiance of exquisite beauty.

When these minute grooves were drawn by Mr Barton upon rock-crystal, he was surprised, upon taking it from the engine, to perceive no traces whatever of his work. The lines, indeed, are so fine, that it is impossible to discover, even by the aid of a microscope, any roughness or diminution of polish, although its whole surface is covered with grooves, in two directions transverse to each other, and at the distance of the 2000th part of an inch. The moment, however, we expose it to the sun, or the light of a candle, we discover the existence of the grooves, from the faint prismatic images on each side of the candle.

We trust that Mr Barton's ingenuity will be amply rewarded by the public taste; and the only regret we feel is, that he should have taken out his patent, before Mr Wrottesley's bill, or some other enactment, shall have secured to inventors, the just advantage of their labours, and put an end to that falla-

cious system of nominal privileges, which has ruined so many ingenious and enterprising individuals.

EDINBURGH, December 2. 1822. O.

ART. XXII.—*Journal of a Tour to the Coast of the Adriatic Sea, and to the Mountains of Carniola, Carinthia, Tyrol, Saltzburg, and Bohemia, undertaken chiefly with a view to the Botany and Entomology of those countries.* By Dr DAVID HENRY HOPPE and Dr HENRY HORNSCHUCH. *Containing the Excursion from the Fichtelberg to Istria.*—Ratisbon 1818.

WE were favoured by the authors of these interesting travels, with a copy of their first volume, as soon as it was published. A translation of it into English was prepared, and we only waited for the two other volumes, which the travellers had promised, before offering the whole to the naturalists of our own country, in a language more familiar to them than that in which the original had appeared. In this agreeable expectation we have been disappointed; the numerous avocations of the authors preventing them, as we have lately learned, from continuing at present their publication. Much as we regret this circumstance, it is yet a satisfaction to know that Natural History continues to be the object of their pursuit, and that their whole time is dedicated to the furtherance of their separate and favourite branches of it.

In order that what is already published of these Travels may not be wholly lost to the British naturalist, we shall in this, and some of the succeeding parts of our Journal, devote a portion of its pages to an account of its details. The scientific information which it contains will instruct, while the narrative of the excursion, written with a degree of zeal and animation that, to to be fully felt, must be perused in the original language, and the scenes of which are laid in a country very little known to British tourists, will excite, we cannot but think, a considerable degree of interest in our readers.

Of the travellers themselves, it may be sufficient to observe, that they are advantageously known to the scientific world, by

their botanical acquirements. Both are considerable contributors to the *Botanische Zeitung*, a periodical work which contains Treatises, Reviews, Extracts, and new information relative to this science, published by the Botanical Society of Ratisbon; and they have also, if we are not mistaken, edited conjointly, specimens of their discoveries made during the tour in question. Dr Hoppe, who resides at Ratisbon, has, notwithstanding his advanced age (which, together with his highly respectable character, has obtained him the title of the "Nestor of German Botanists), undertaken several extensive alpine journeys, in search of the plants of his native country. These he has made known to the public through the medium of his *Botanische Taschenbuch*, for the years 1790,–91, &c.; of his *Herbarium vivum plantarum rariarum præsertim alpinarum*, 4 cent. in folio; and particularly of his beautiful *Decades* of specimens of German Grasses, which are now in the course of publication.

Dr Hornschuch, the favourite pupil of the venerable Hoppe, is Professor of Natural History in the University of Griefswald, a town of Pomerania, on the shores of the Baltic Sea, and has the charge of the Botanic Garden there, established by the Prussian Government. Cryptogamic plants have occupied much of this gentleman's attention, and his history of the two new genera of *Systylium* and *Voitia*, his account of some foreign mosses in the *Horæ Physicæ Berolinenses*, and his Memoir upon the propagation and metamorphoses of the lower orders of vegetables, published in the *Nova Acta Physico-Medica Acad. Cæs. Leop. Car. Nat. Curiosorum*, shew him to be perfectly master of this subject; add to which, in company with the celebrated Dr Nees Von Esenbeck of Bonn on the Rhine, he is considerably advanced in the publication of a German Muscologia, the appearance of which the lovers of that beautiful family of plants are anxiously and almost daily expecting. The preface of the work which we are about to notice, commences by an apology for the plain and simple style of the narrative, which is professed to be chiefly written for the perusal of travelling naturalists, and goes on to acknowledge, with grateful feelings, the assistance which the writers received during their journey, from many individuals, several of them men high in rank and in literary reputation. The remainder of the

publication is given in the form of letters, the first of which is dated Gefrees *, in Upper Bayreuth, 22d January 1816, and is devoted to an account of the plan of their expedition, and their preparations for it.

"We intend, to-morrow morning, to commence our pedestrian tour, proceeding from this place by Ratisbon, Saltzburg, Klagenfurt, and Laybach to Trieste, thence making various excursions, according to circumstances. Trieste will be for some time our head quarters, whence we shall go through Istria to the Cape of that name, to Fiume, over Monte Maggiore, to Pola, Parenzo and Pirano, thus passing the spring in a country which the celebrated Professor Host †, who was born at Fiume, has called the Paradise of Flora. Our journey will be continued through Duino, Montfalcone, Aquilea, Gradiska and Gorz to Istria, thus skirting a part of the provinces of Friaul and Carniola, and proceeding over the mountains of Carinthia and Tyrol to Heiligenblut and Gastein, where we shall again rest. We shall thence return by Saltzburg, and the termination of our expedition will be celebrated at Bryzezina in Bohemia, the seat of Count Sternberg ‡, who has already given us a most cordial invitation."

"But, in order that we may not commence our tour quite unprepared, we have passed a month here (in Gefrees) with our excellent friend and naturalist M. Funck ||, apothecary, en-

* A small town in the Bavarian States, a few miles north of Bayreuth.—Ed.

† Now resident at Vienna, author of those admirable works *Gramina Austriaca* and *Flora Austriaca*, and who, we hear, is occupied now with a work on the *Salices*, in the same splendid style as the first named one on the grasses.—Ed.

‡ Count Sternberg is the author of the best monograph of the genus *Saxifraga* that has ever yet been written. This work is published on a folio size, with numerous excellent plates, and is entitled *Revisio Saxifragarum iconibus illustrata*; but, since the period of its appearance, 1810, so many new species have been discovered, that it were much to be wished its author would give us a supplement on the same plan. The Count is favourably known also to the geologist as well as the botanist, by the publication of his *Versuch einer geognostisch-botanischen darstellung der Flora der vorwelt*, likewise in folio.—Ed.

|| An author well known by the publication of the *Cryptogamic Plants of the Fichtelberg*, in several quarto fasciculi, and who deserves to be much more so by that of his *Deutsche Moose*, or, as he describes it, *A Pocket Herbarium to be ca-*

riching ourselves with his experience, gained by travels in the Fichtelberg and the Alps of Switzerland and Saltzburg; examining his collections of subjects of natural history, and making especial use of that part of his library which relates to the southern borders of Germany. Thus we have become familiar with the writings of Scopoli, Wulf and Host, and with the *Travels* of Seenns and Schwaegrichen. But the works of the greatest value to us were the *Flora Germanica* of Schrader, which, as is well known, and, fortunately for us, includes the plants of Istria, and Sturm's *German Fauna*, which contains the *Coleopterous insects* of Carniola, and of the southern shores of Germany. These valuable aids were not only closely studied by us, but, along with Host's *Flora Austriaca*, Röhling's *Deutschland's Flora*, (third part), Willdenow's *Carices* and Schultes' Travels to the Glockner, were consigned to our portmanteaus."

"Thus did we pass many successive evenings in laying our schemes for our proposed tour, and in agreeable and useful conversation, which frequently became quite enthusiastic. One of us would suddenly take from Funck's collection a fine specimen of the rare *Carabus Gigas*, to shew what we had to expect; whilst another sought out the figure of it in Panzer's *Fauna Germanica*, or *Creutzer's Entomologia*, in order to compare the individual with its representation; and a third read the history of the insect from *Sturm's Travels*. Then would we behold in anticipation a whole regiment of the rare *Carabi*, which are peculiar to the southern parts of Germany, such as *C. cælatus*, *Creutzeri Germari*, *emarginatus*, *oblongus*, *catenatus*, &c.; and would wish ourselves immediately in the woods of Istria, that we might in reality capture these entomological treasures."

"Other hours were dedicated to Flora, when the plants seemed to pass before us in review. Thus, when Wulf relates, amongst other particulars of the *Euphorbia Characias* (*Red*

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ployed in Botanical Excursions, Bayreuth, 1820. This admirable work consists of sixty loose leaves of small 8vo. paper, divided on one side by lines into as many partitions as there are mosses of Germany, and in each is placed a specimen, with the name of the species. These are accompanied by a small descriptive book in Latin; and the whole are inclosed in a case, which scarcely occupies more room in the pocket than a common pocket-book.

Spurge), "*habitat maxima in copia prope Contovello inter Tergestum et Duinum, intra rupes mare spectantes, florens primo vere, grato spectaculo ob florum multitudinem*," we were immediately transported in our idea to those delightful countries, collecting their botanical rarities under a brilliant sky, and directly in view of the Adriatic sea: fully entering into Schwaegrichen's expression, "every one at Trieste speaks with rapture of Flora's lovely spring." Our feet seemed spontaneously to move, as if we feared, by every moment of delay, that we might lose the proper season. Thus were we amused at the residence of the excellent Funck, who, unable himself to quit his occupations, and join our party, was only consoled by the conviction, that in all our excursions the enrichment of his collections would be borne by us in mind.

"The time thus spent in the agreeable anticipation of our journey will not return to us; but its memory will remain as long as we exist. May the fulfilment of our intentions prove as happy in reality as it has done in prospect; and when possessed of the treasures which we expect to obtain, may these contribute to the extension of the knowledge of Natural History! Thus will the pleasure be continued to us, and we shall not envy those individuals who cannot enter into our feelings. "*Qu'importe d'ailleurs aux sciences naturelles quelques éloges, ou quelques critiques de plus? Le Naturaliste devoué, entrainé par son étoile, par ses goûts, ses penchans, se trouve souvent irrité, provoqué même par les obstacles, et peu flatté par les éloges. Le succes, la verité, seuls le soutiennent: il poursuit sa carrière, et ne doit redouter ni le blâme ni le ridicule des écrits parasites.*" —Villars.

"*Bayreuth, January 23.*—We have commenced our tour, and have already proceeded five leagues. The fancied alarms of fatigue from long marches over high mountains, in the depth of winter, of dangers threatening us by day and by night, of avalanches that would bury us alive, and wolves that would devour us, suggested by the anxious affection of our friends, as about to surround us on every side, have all vanished."

The weather is clear, the snow-paths very good, and every thing corresponding to our wishes." Even in the case of pass-

ports, which are so troublesome in the little principalities of Germany, our travellers had their difficulties removed by the friendly aid of the superior officers. On the following day they reached Thunbach (6 hours), on the 25th Longfeld (9 hours), where their fare was miserable, and straw served them for a bed. According to their own account, however, they slept well. " The pedestrian," say they, " never can meet with an intolerably bad lodging, either on the hills or in the plains; having hunger, which is the best cook, and chearfulness and fatigue, which are the grand requisites for sleep." On the 26th they reached Ratisbon, a long stage of 13 stund, and passed three days among their scientific friends resident in that place.

On the 29th they arrived, after a walk of 9 hours, at Straubingen, having, as they journeyed, been favoured with a distant view of the rich country on the banks of the Danube, the mountains and woods of Stanf, Sulzbach, Bach and Woerth, where these naturalists had formerly wandered in search of plants. Straubingen, happily for them, afforded an excellent inn, a circumstance which calls forth an observation, to the truth of which most of our botanical friends can testify ; " that, although travellers in pursuit of objects of natural history, can accommodate themselves to every situation, and, under all circumstances, can shelter themselves under the mantle of content; yet, that when they meet with good entertainment, they know how to enjoy it like the rest of mankind."

On the 30th they proceeded on to Seimbach, again 9 hours, leaving at Eiterhofen the Vienna road: passing the Iser below Landau, and there, entering a mountainous tract of country, they gradually ascended to the snowy regions of the Red-Stadtler Tauerns and the Loibets.

Marchl (8 hours) received our travellers on the 31st of January, their track having lain mostly through an alpine country, where the pine-trees, laden with snow, presented a striking appearance. On the 1st of February they crossed the Iser, and entered the territory of Saltzburg, where a different scenery, truly alpine, its inhabitants peculiarly dressed, and speaking a dialect distinct from any that they had yet witnessed, excited

their attention. On the evening of that day they arrived at Lauffen, having performed 10 hours.

"*Saltzburg, Feb.* 2.—We have at length reached the famed city of Saltzburg, and thus arrived at the second head-quarters which we have proposed to make on our journey. Klagenfurth will be our third, Laybach the fourth, and Trieste the fifth. We set out this morning with our wonted chearfulness. A clear sky, delightful prospects, and well-trodden paths, are in themselves capable of conveying happiness to minds predisposed to contentment. It is a *jour de fête*, and an interesting circumstance occurred to us: for as we were following each other along the snow-path, the foremost of us suddenly stopped, and immediately communicated to those behind him, his own sensations, on seeing written, in beautiful German characters, upon the snow, that most perishable of all elements, the words, "*Let nothing trouble thee.*" These were destined by the hand of a mistress, for the eyes of her lover, who was to follow; and they were not lost upon us; for we declared that they should serve for a motto to us, whenever any thing should occur that would be likely to ruffle our tempers At Saltzburghofen, the stage which immediately followed, we found a very obliging hostess, who kindly prepared the coffee we had brought with us; but who, except for the bread and cream, would absolutely take nothing. Here, therefore, we had no occasion which could call forth the use of our motto."

Three days were devoted to Saltzburg, and to visiting M. Hinterhuber, Professor of Botany, and M. Mielichofer *, who presented MM. Hoppe and Hornschuch with many rare alpine mosses from the vicinity of Saltzburg. Nor should the name of M. Doestser of Nounthal be omitted, a good botanist and chemist, who is always ready to shew hospitality to the travelling naturalist, and at whose house Funck, Martins, and Hoppe have frequently sojourned, when on their excursions to the neighbouring mountains.

On the 4th of February the travellers approached the Untersberg, "which, notwithstanding the wintry garb in which it is

* After whom our Carex Mielichoferi is named.

clothed from head to foot, we cannot withstand the temptation of ascending, even during the present inclement season. In proceeding thither, when you go forth from the new gate of Saltzburg, and look towards the south, and see before you the whole range of mountains in their white gala dress, their sides clothed with pine forests, also the lofty Göhl, you will behold indeed a magnificent sight, and confess that the situation of the city of Saltzburg is singularly beautiful."

"The kind people at the Stone-bridge of Untersberg received us in the most friendly manner, and invited us to dine with them. In the afternoon we hastened to the Prince's Well, to see this famous spring in its winter-attire. Hitherto we have been directing our attention to the romantically grand and sublime in scenery, enjoying the sight of the beech and maple trees loaded with snow, and of the torrents rolling over beds of vast stones. But now we must examine its smaller details: "Cum omnia circa nos torpescunt et languescunt, cum flumina rigent, nemora silent, campi latent nivibus obrecti, ubique luctus, rerum facies decolor et tristis mortis imago; musci inter vegetationis ruinas emergentes et sericeo colore fulgentes, rupes et lapides obducunt." To the truth of this, the steep face of the rocks now bore witness. Here, among other mosses, we found *Bartramia Œderiana*, *Neckera crispa*, *Tortula tortuosa*, and *Mnium (Bryum) rostratum*, all in the finest state of fructification. The soft bed of the spring presented us with another spectacle, for it was entirely covered with large specimens of the rare *Gymnostomum aquaticum* of Hedwig! What botanist can have an idea of our pleasure at this glorious sight! Often had we regretted our inability to behold, like Rohde, the celebrated fountain at Vaucluse *, the favourite spot of the poet Petrarch, and there to gather the *Gymnostomum aquaticum*. Now we have met with it in a spot which may be supposed to be of greater interest to us even than Vaucluse.

"This was the first botanical harvest that we had made in

* No where does this charming moss grow in greater plenty and perfection, than at the fountain of Vaucluse, whence we have numerous specimens.—Ed.

the present year, the first specimens that we had added to our collections, and, what was still more important, the plant in question was also an addition to the Flora of Saltzburg. As, however, nothing is perfect in this world, so our beautiful moss is destitute of fructification, a circumstance which may readily be accounted for in the extreme coldness of the water wherein it grows. For without warmth it cannot fructify. In this spot, inviting to us on many accounts, we remained so long, that night came upon us before we were aware of its approach. As a matter of necessity, therefore, we accepted the friendly offer of Councillor Storck, and slept at Glaneck."

" *Saltzburg, Feb.* 5.—Dr Storck and his excellent family shewed us great kindness, and gave us letters to the inhabitants of the mountains. We were invited by Mr Doestter to dine upon roasted beaver, and, what gratified us still more, we had the opportunity of inspecting, through the kindness of M. Fæset, his zoological cabinet, which is highly interesting, and constitutes one of the objects in Saltzburg that no stranger should omit seeing. This gentleman made the collection for himself, but it now belongs to government, and is placed in the great hall of the College, where, under the superintendence of M. Fæset, it is continually increasing. It contains all the quadrupeds and birds that are found in the district of Saltzburg, preserved in the very best manner, and among them are many that are very scarce, and only seen on the mountains. It includes likewise fishes, amphibia, insects, shells, eggs, &c., and plants and minerals have also lately been added to it. The whole does honour to the industry and ability of M. Fæset, and the thanks of all naturalists are especially due to the members of the government, who had sufficient spirit and good taste to take possession of the whole for the benefit of the state."

" *Werfen, Feb.* 6.—*Trichostomum fontinaloides* *.—Early this morning we directed our steps to the south of Saltzburg, in order to traverse the narrow mountain passes of this country.

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* Many of the letters are thus headed with the name of some rare plant or some interesting object, which is intended as a motto to the letter, or as indicating its principal contents.—Ed.

So striking was the scene before us, the immense snow-covered Alps losing themselves in the blue distance, that we were tempted to believe, that a mountain view is as striking in a clear winter's day, as it is in summer. Hallein, Kuchel, and Golling were soon passed, but it was otherwise with the rest of the road. Immediately behind the famous pass of Lueg, of which not a trace now remains, the vast blocks of stone which jut out of the softer banks of the Saltza, invited us to a closer examination, and we found them to be covered with the rare *Trichostomum fontinaloides*, in collecting the finest specimens of which, we spent some hours. This was again an addition to the Flora of Saltzburg; and its discovery detained us so long, that day declined before we could reach our resting place. The moon, instead of the sun, was our guide; and, singly and carefully, we proceeded onward across vast mountains covered with dazzling snow.

" *Foot of the Tauern* * (*Untertauern*).—*Gymnostomum, nova species* —We had a good lodging last night at the post-house of Werfen, where the warm room was particularly acceptable, and served to dry our clothes, which had been thoroughly soaked by the Saltza. The distance to Untertauern this day was not less than ten stund. We have crossed the Saltza, Radstadt is behind us, and a solitary cottage at the foot of Radstadt. Tauern is to be our lodging to-night. Even to-day we can enter on our journal the ' nulla dies sine linea;' for we found that the perpendicular, and therefore snowless, mountains of mica-slate, which bound the lonely alpine road before Hüttan, harboured a beautiful velvet-like moss, which had hitherto escaped the observation of muscologists, and which must, therefore, serve to record our ardent zeal for botanical honours. It was a new *Gymnostomum* †, which thus unexpectedly presented itself to our view. Our travelling bundle was in-

* Tauern throughout Saltzburg and Carinthia, is applied to every hill over which a road or path leads. Probably from the Celtic word *Tur*, a hill; and hence in Scottish Tarn, and Tor in the south-west of England, namely, a high rock.—Ed.

† This has been published in Hooker's Musci Exotici under the name of *Anictangium Hornschuchii*.—Ed.

stantly thrown down, our knives drawn forth, and we assiduously fell to work in collecting and filling our boxes. So intently engaged were we in this agreeable operation, that the most profound silence prevailed throughout our party, save when one of us shouted at the sight of an unusually fine specimen. The very passengers on the road expressed aloud their astonishment at our employment."

On the 8th of February, these ardent naturalists commenced their walk over the Tauerns of Radstadt. The weather was favourable, and the paths excellent, except near the summits, where the snow was loose. Many a little détour did they make in search of aquatic mosses, at which, with the risk of having their fingers frozen, they arrived, by delving away the deep snow at the margins of the rivulets. They contrived, however, to get *Trichostomum riparioides*, *Fontinalis antipyretica*, and *Hypnum riparium*. At the top of the Tauern is a little inn, and about an hour from it the church-yard, considered to be the most elevated in Germany. Near this place was observed the brook where Michl, the minister of Mauternsdorff, had detected the scarce *Juncus castaneus* of Smith, which was a new discovery to the German Flora. In their descent they gathered specimens of the beautiful snow-white granular limestone, for which that country is celebrated; and, after a fatiguing walk of eight hours, arrived at Mauterndorff.

"*Seebach, Feb.* 9.—*Tempora mutantur*, &c.—The scene has changed. An immense quantity of snow has fallen during the night, and the same weather continued the whole of the forenoon, accompanied by a violent wind. For two good hours, in our way to Taunsweg, we had to wade continually up to the knees in snow. Here, however, we were able to refresh ourselves. We found a good inn, and had letters of recommendation from Counsellor Storck. Perhaps we should have remained here, although we had only gone three hours; but an opportunity presented itself of continuing two hours further. The hostess informed us, that the peasants who had brought iron from Steir-markt, would return with empty sledges. We remembered how rapidly we had descended a part of the Tauern upon sledges, and agreed to give a fair price for the use

of these to Ranten. When we were about to take our seats, instead of a single sledge we found three, but provided neither with a covering nor straw. Each was drawn by one horse, and there was only one driver to the whole. Each of us, therefore, had the privilege of driving his own obstinate jade, which on no account whatever could be made to go out of his usual pace. The carriage had nothing in common with our rein-deer sledges, but the construction of the under part of it. It is raised very little above the ground, yet it is sufficiently broad on all sides for you to be at your ease; and we were perfectly secure from breaking our necks. Still we could not continue this mode of travelling long, for we were almost frozen. We got out at Seethall, and left the countryman to proceed where he would with his fare of 10 batzen. It was now dark, and on no other consideration would we have slept here. The warm room was the very balsam of life to us. But, on entering the dwelling, it was horrible. As soon as we had closed the ponderous door, it was as if we looked upon the true picture of a den of thieves. The black walls were dimly lighted by some scattered chips of wood, so that what was in the back-ground could not be distinctly seen. Of the many male creatures in the room, two sat on benches, the others on tables; their long uncut hair hanging down in front to their chin, and behind over their shoulders. The burning heads of their tobacco-pipes, to which no stem was seen, stuck out of their mouths like a second nose from among their long lank locks of hair. A large hat, with a very broad rim, overshadowed the whole. The females were employed in spinning by the aid of the feeble light. Nevertheless, we found them honest and kind people; the girls amusing us with their provincial songs, which lasted till midnight, when we all betook ourselves to rest."

The road to Tiefenbach, which was passed on the 10th, was through a country wild and romantic, and the effect of the scenery was heightened by the numerous pines and alders which were torn up by their roots, by tempests; and by the whole country being covered with snow, whilst the branches of the trees were completely bent down by its weight. Still, on the perpendicular limestone-rocks, the beautiful Gymnostomum curviros-

trum was gathered, and whole flocks of siskins *(Fringilla spinus)* were seen feeding on the seeds of the alder. This day's journey was 9 hours.

From Tiefenbach to St Viet's was 10 hours. The country of Carinthia was entered at Friesach, and an evident alteration for the worse was visible every where. "We have left in Bavaria and Saltzburg a blessed country, with friendly innkeepers, good beer, and bread and cheese, and milk : of all which we find nothing here; and what there is in the way of food, is bad and dear, notwithstanding the circulation of paper money. The wine, to one accustomed to beer, is quite unpalatable; and we stopped for refreshment only once the whole way, namely, at Friesach; but here we were badly off, and were frequently obliged to recur to the motto, "Let nothing trouble thee!" Our landlord invited us in vain, by a lengthened humorous inscription over his door.

At noon, on the 12th of February, our travellers entered Klagenfurt, where their passports again occasioned them much inconvenience, and in the evening, entered Rosenthal, they crossed the Drau, and slept at Kirschentheuer.

"*Newmarkt, Feb.* 13.—*The walk over the Loibl, and entrance into Carniola.*—The fatigue attending this day's excursion far exceeded all former ones. We have crossed the Loibl, which is a second Radstadter Tauern, but surpassing it both in the length of the way, and in the height of the passes. We took a second breakfast at a small public-house, where one of our party, fourteen years ago, resided for three weeks, for the purpose of botanizing on the mountain; but the old people were dead, and new faces supplied their place. Upon the highest point of the hill is the line of separation between Carinthia and Carniola, and we entered this latter country with some anxiety; for we had not heard much in praise of the inhabitants of this remote district. Their hospitality was untried, and their language unknown to us. Nevertheless, we found the people every where move their hats to us, saluting us with the Christian salutation, in the language of Sclavonia: *Gualem Jesus Christus.* A party of natives going to a wedding, in an open sledge, shouted aloud, as soon as they perceived us.

"Under these agreeable impressions, we reached Neumarckl, where it appeared to be holiday; and the whole place was filled with carriers. Two travellers, who were here before we arrived, assured us, that they could not, any where, procure a lodging. We were, therefore, agreeably surprised to find,' at the inn, to which we had been recommended, a good warm room, and a hostess, who addressed us as welcome guests, in the German language. We had even the luxury promised us (which had long been denied us), that if we would take off our shoes and stockings, we should have them cleaned and washed, and ready for us early the next morning."

Neumarckl is inhabited by people who are employed as labourers in the neighbouring iron-works; and it is a great rendezvous for carriers, who, by considerable exertion, convey goods to the top of the Loibl. Here, therefore, is good fare, and good wine provided, and as, in addition to this, the music struck up in the evening; and as the beauties of Carniola offered their hands for the dance, the Fichtelberg botanist (although much fatigued by a walk over the mountain of 8 hours) could not do otherwise than join in it.

"*Laybach, Feb.* 14.—The walk to-day amounted to 10 hours; that is, four to Krainburg, three to Zwisscheenwasser, and three to Laybach. Carniola presents a beautiful tract of country, the valley wide, intersected by charming rivers. The plains, now covered with snow, would appear to offer in summer fine corn and meadow-lands, whilst the distant mountains, clothed with evergreens, and the numerous shrubs by the road side, must afford an excellent field for the entomologist.

"*Oberlaybach, Feb.* 15.—Before quitting Laybach, we paid a visit to Baron von Zoys, a name which is commemorated by the mineralogist in the Zoysit, and by the botanist in the Zoysia. The old man received us in his wheel-chair with great affability, and entertained us, for some time, in relating such things as had reference to our journey, and particularly with the natural history of this and the neighbouring countries."

Here our travellers were made acquainted with the great difficulty there would be in getting to Trieste, as the roads were

blocked up by the immense quantity of snow, that had fallen,—greater than was ever before known. Nevertheless, they were not deterred from their enterprise, but set out, and reached Oberlaybach, 4 hours, in the evening.

"*Prewald, Feb.* 16.--A ride in a Carniola sledge.—We have to-day travelled over a tract of country of 12 hours in extent; which, for the quantity of snow, might vie with Siberia in the depth of winter.

"We were comfortably served in the post-house at Upper Laybach; supplied with a regular supper, and we slept in good beds, in a well aired room; for which, however, we paid, including our breakfast, 4 florins and 12 creutzers of our money. When we were within 2 hours of Upper Laybach, we found traces of the snow-storms of which we heard yesterday, such as were never known in the memory of the oldest man; and we experienced great difficulty in walking through the deep snow. The accounts we had of the state of the roads between that place and Prewald were still worse. We, therefore, gladly embraced the opportunity which chanced to present itself, of proceeding for 3 posts in a return sledge, which had plenty of straw and a woollen covering. For 3 florins, with the aid of two small but swift horses, we had a ride in a sledge of the country through Loitsch and Planina to Adlersberg, where we arrived sufficiently early in the afternoon, to proceed without much fatigue to Prewald. During this ride, we travelled continually over a road of deep loose snow, with high banks of snow on each side of us, presenting a most remarkable scene. Nova Zembla could exhibit nothing of the kind more extraordinary. The villages by the road-side were buried in snow; and nothing but their roofs could be discerned. If Planina, situatedin a level country, offered so singular an aspect, how much more imposing was the view of the lofty range of the Adlersberg, which we reached by a serpentine road, made with great art. Many hundred men were employed in clearing these roads, and waggons and sledges were here and there buried in the snow. Men and cattle were found frozen; and, amongst others, two soldiers standing up right, with their arms in their hands. At Prewald, we found a great number of men and carriages; and we counted ourselves

fortunate to have obtained shelter, although we had to occupy a straw-bed, in company with many other travellers."

" *Trieste, Feb.* 17.—From Prewald to this place we were able again to walk, for the high wind had sufficiently dispersed the snow on all sides of the barren rocky plain. Instead of the lofty Loibl which we have left behind these two days past, we have had the Monte Nanus, well known to botanists.

" We experienced several changes of climate, in a walk of 5 hours to Sessano. At first, the weather was perfectly calm, with a clear atmosphere. The nearer, however, we came to Sessano, the more lowering the sky became, till at length the black clouds discharged themselves in long continued falls of snow. This stormy weather, which lasted for more than two hours when we were close to Trieste, formed a striking contrast to the description which had been given us of the mild winters of this city, and made us entertain fears lest we should have arrived too early for the spring-flowers.

" From Sessano, where we dined, we proceeded 2 hours to Obschina, where we were obliged to show our passports.

" We had now a gradual ascent before us, from the summit of which, we were to distinguish, for the first time, the long wished for Trieste, (the country where the Citrons blossom,) and the mighty surface of the Adriatic Sea. For a length of time, we advanced at a very slow pace, as if to enjoy the pleasures of anticipation, which Baron Von Seenns, by his travels into Istria and Dalmatia, had taught us to expect. At length, when we were near the top of the hill, curiosity triumphed over these feelings, and each hastened forward, striving to be the first to enjoy the majestic prospect. We were, indeed, astonished. We had often viewed from the summits of high mountains, large tracts of country, with fertile meadows, rich corn-fields, and numerous villages; but such a vista of a vast extent of water, melting in the distance into the horizon, of numerous ships in the harbour, forming as it were a second city to the proud Trieste, which we were about to inhabit for some weeks, and the vegetation of whose neighbourhood we were to explore, we never before beheld.

" Hence to Trieste was a continual and steep descent for more than a quarter of an hour. This hill is excessively fatiguing

to the cattle dragging the heavy loaded waggons from a great commercial city.

"Here, then, we have arrived at one of our first main points of destination, after having travelled a distance of 170 hours in the space of twenty-one days."

"Some days were occupied by our travellers, in delivering their letters of introduction at Trieste; in securing a convenient lodging, which they did at Hundsberg, a short walk from the city; and in preparing materials for collecting and preserving the various specimens of natural history which they hoped to obtain. Still more time was lost by the badness of the weather, and unusual lateness of the season. The almond-tree, which usually blossoms at Trieste in the middle of the month of February, was now scarcely in flower at the latter end of it. In the market, indeed, were some hyacinths, violets, narcissuses, and jonquils. Our authors employed a part of the time they were thus detained, in writing, for the benefit of other pedestrian botanical tourists, an account of the dress which they wore upon their excursion. Linnaeus did not disdain to employ his pen on a similar subject; and, if the two accounts be compared, it will be seen that, in point of convenience, if not of cleanliness, the *under-dress* of the German naturalists is to be preferred to the leathern breeches, round wig, half shirts, and false sleeves of the immortal Swede.

"A pair of new, woven, mixed-grey cotton stockings is an essential article. They are loosely tied under the knee, with elastic knitted garters, fastened by a loop. An under waistcoat of wool, knitted, or of English flannel, must go over the body. Long linen drawers, extending to the ancle, and there fastened by a broad ribband over the stockings, and buttoned above, to the waistcoat, to prevent their falling down, together with a coloured neckcloth, form the entire of the under-dress. This is not to be taken off during the *whole journey*, not even at night, and has the following important advantages:—We are protected in dirty beds from contagious diseases, as well as from the attacks of entomological productions inhabiting such places. We have a warm covering in scanty beds and cold rooms, and lose no time in removing this part of the dress at night, or by putting it on in the morning. For the upper dress, stockings of the same

materials as those formerly described, and drawn over them and the drawers; a pair of strong boots, with nails or iron on the heels; a warm winter waistcoat, and a second neckcloth; pair of long and wide cloth small-clothes, covering the boots and part of the waistcoat; a cloth coat, with short flaps; and a spencer of the same, go over the whole. A winter cap, lined with fur, and provided with ear-lappets, is the ornament for the head; and a pair of gloves of similar materials, is certainly suited to the season of the year.

"This is a comfortable dress, and proof against cold, rain and wind."

(To be continued.)

ART. XXIII.—*Historical Account of Discoveries respecting the Double Refraction and the Polarisation of Light.* (Continued from Vol. IV. p. 130.)

PERIOD III.—*Containing the Investigations of Beccaria, Martin, Haüy, Wollaston, and La Place.*

SUCH of our readers as have taken an interest in the history of the Polarisation of Light, must have ascribed to negligence the delay which has taken place in the progress of this series of papers. Having arrived at the period which embraces the experiments of Benjamin Martin, we were desirous of obtaining copies of the Essays which he published on this subject; but with all our diligence we were not able, on account of their great rarity, even to obtain a sight of them. Through the kindness, however, of Mr William Jones, optical and philosophical instrument maker in London, who has transmitted to us copies of both Mr Martin's Essays on this subject, we are now able to resume our labours. As these pamphlets are extremely rare and curious, we have thought it better to reprint them entirely, than to lay before our readers merely an abstract of them.

Sect III.—*Account of the Experiments of* Mr Benjamin Martin.

The following Pamphlet, which is published without a date, is entitled, *An Essay on the Nature and wonderful Properties of Island Crystal, respecting its manifold and unusual Refraction of Light.* By Benjamin Martin.

"Island Crystal is a subject of so singular a nature, that it has attracted the attention, and excited the curiosity and admiration of all mankind since its discovery by *Erasmus Bartholine*, about 100 years ago, who was the first that gave any account of the figure and properties thereof to the public.

"The great Hugenius soon after published his treatise on light (*De la Lumiere*), and gave us therein a more correct and particular account of this substance, in regard to its peculiar forms, dimensions, and strange refraction of light. And because that book is now rarely to be met with, and no extract having been made from it (but a small sketch in Sir Isaac Newton's optics) that I know of, I have thought my spare hours could not be better employed, than in translating so much of that valuable work as immediately relates to the subject of Island Crystal; especially as I shall thereby have an opportunity of adding several new experiments and observations, concerning its wonderful properties of refracting light.

"This species of crystal was originally brought from *Island* (or *Ice-land*), an Isle in the Northern Sea, about Latitude 65 degrees, and from whence it took its name; but it has since been found in many other parts of the world, and very plentifully in Great Britain, particularly in the peak of Derbyshire, though the greatest part is not very transparent.

"The form of this crystal or talk, is that of an *Oblique Parallelopiped*, as represented in Plate III. Fig. 1. by ACBDEKFL, with six parallelogram sides, and eight solid angles. Two of these solid angles opposite to one another, as C and E, are compassed each of them by three equal obtuse angles, each equal to 101 degrees and 52 minutes; and the other six solid angles, A, L, F, D, B, K, are each contained under one obtuse angle, and two acute ones of 78° 8′ each.

From the angular point B let fall a perpendicular BI to the ground-plane, and through I draw KM indefinitely; then will the angle BKI be 70° 57′, the obliquity of the edge or line BK of the solid; and its complement the angle IBK will be 19° 3′. Let h K be perpendicular to the side BC, as also the line $h\,i$; then the angle ihK was found by exact measurement to be 105 degrees, which is the measure of the inclination of the planes ACBD and CBKF to each other.

Let a plane CGHF perpendicular to the horizon, be supposed to cut the solid through the side or edge CF, then will it evidently bisect the obtuse angle ACB, and so make the angles ACG, BCG, of 50° 56′ each. Also it is evident, the lines KM and FH will be parallel. Draw the diagonal CH. Then our illustrious author proceeded to computation in the following manner.

Let C be the vertex of a *triangular* pyramid (in the centre of a sphere) contained under three equal and equi-angular planes ACB, ACF, BCF, (Fig. 2.), then will the base of the pyramid be the spherical triangle A B F, equilateral and equiangular. And then it is plain, that each angle as A measures or is equal to the inclination of the two containing planes ACB and ACF; and each side of the triangle as AB is the measure of the opposite angle ACB. And further, if any angle as ACB be bisected by a line C G, it will of course also bisect the side AB, and drawing the arch FG, it will bisect the angle at F. In like manner, if the side B F be bisected in O, the arch A O bisects the angle at A, and cuts the other arch FG in H, the pole of the sphere; and CH is the semiaxis thereof. Lastly, suppose the three plain angles which compose the solid angle C in each figure the same.

Then because A F B is equal to IhK (in Fig. 1.) or 105 degrees, the half thereof AFG will be 52° 30′, and the angles at G being right ones, all the angles of the right angled triangle AFG, or BFG, are known; and therefore the side AF, or BF, will be found to be 101° 52′, which is, therefore, the measure or quantity of each *obtuse angle* forming the solid angles C and E in the Island Crystal.

In the same triangle AFG, the side or hypothenuse F G is found to be 109° 3′, and as this is the measure of the angle FCG (Fig. 1.), so its complement to 180°, viz. 70° 57′ will be the quantity of the angle CFH or BKM in the crystal; and, therefore, the angle IBK will be 19° 3′, as we have said.

Lastly, it is evident the arch GH (Fig. 2.) is the measure of the angle GCH in the crystal (Fig. 1.) and in the right angled triangle AGH, there are two parts known, viz. the side A G of 50° 56′, and the angle G A H of 52° 30′, therefore the side G H will be found to be 45 20′, and such is the inclination of the axis CH to the bisecting line CG. These are all the dimensions of the crystal necessary for our present use; and now we proceed to specify and recount the unusual properties of refraction in this sort of crystal.

The singular effect of island crystal is, that of shewing objects *double* by a *double refraction of light*. Diaphanous bodies in general, as glass, water, &c. refract a ray of light in its passage through them; but they do not divide that ray into two, and so can shew only *one*, and not *two different* and *equal* images of the same object, as we always see in the crystal we now speak of.

The manner in which this double refraction is made, is best conceived from the figure. Let PO be a beam of light falling upon the upper surface AB of the crystal, in a perpendicular direction, and in the plane FCGH, which bisects the angle ACB Then will this beam at its entrance become divided into two, viz. OQ and ON, both which will be in the said plane FG. The beam O Q is in the same direction with O P. and goes through the crystal without refraction. The other part or beam O N is refracted, so as to make the angle QON always equal to 6° 40′ very nearly, as is found by experiment.

If the said ray falls any where else in the surface AB, the refraction will ever be made in a plane parallel to the plane FG, so that the refracted parts will always be in a line in neither surface, parallel to the line FH; and always make the same angle equal to QON.

Any ray *cd* that falls obliquely upon the surface, will be refracted in the same manner, viz. into the two beams *de*, and *df*, in a plane *a*DE*b* parallel to FCGH, and in an angle *cdf* equal to the angle QON.

From what has been said, it evidently follows, that if Q be a point in the lower surface of the crystal, and directly under the eye at P, then a ray of light proceeding from any object placed

in that point Q, will in its passage through the crystal be divided into the two parts or beams QO, QS, of which the part QO proceeds directly to the eye without refraction; but the other is refracted to S, making the angle OQS equal to QON, in the same plane FG.

A ray of light NO in the substance of the crystal will be equally refracted into the air at each surface, that is, the refracted parts OP, NZ will be parallel to each other; therefore since the ray QS is parallel to NO, it will be refracted into ST parallel to OP, and so the point Q (or any object placed in it) will be seen by the eye by two different rays of light OP, ST. Continue the line TS till it cuts the line FH in R; then will the object at Q be shewn at Q by the ray QP unrefracted, and at R by the refracted ray QST, and therefore it *must appear double.*

Let L*g* bisect the acute angle at L, which will therefore be perpendicular to the line FH; through Q and R draw two lines VW, and XY, parallel to L*g*; then it will follow, that all the points Q in the line VW will be refracted to the line YX, and consequently the image of the said line will be double, or it will appear in the two parallel lines VW and YX.

If the crystal were made to move round upon the point Q, the primary image of an object at Q would appear at rest, while the secondary image at R would be seen to move in a circle round it.

If the object be a right line, then the distance between the two lineal images, viz. QR, will be the greatest of all when the plane of refraction FG is in a *direct position* before the eye; the images being always necessarily parallel, it is plain, that while the crystal moves round upon the point Q, the moveable image XY will approach nearer to the primary image in the line VW, till at last it coincides with it, and both the images appear as *one line*, and that will be when the said plane FG is in a *right position* to the eye.

By continuing the motion of the crystal, the secondary image YX will separate from the other quiescent one VW, and appear on the other side, increasing the distance till it becomes equal to QR again, when the plane FG is direct before the eye as at first; and upon turning the crystal another quarter of a circle,

the said plane FG is again right to the eye, and two images coincide in one as before. In short, the moveable image YX will always be parallel to VW, during the whole rotation of the crystal, about the centre Q.

Sir Isaac Newton calls the plane FCGH and all others parallel to it, *planes of perpendicular refraction.* Let FCGH be such a plane described out of the crystal (Fig. 3.) and let PO be a ray of light falling upon it in O; through the point O, draw the perpendicular BN, and upon it as a centre describe the arches AB, IK; from the point A where the arch cuts the ray, draw AD perpendicular to BN, and it will be the sine of the angle of incidence AOB: let this be divided into five equal parts, and make EK (the sine of an arch IK) equal to three of those equal parts, and through the point K draw OL, which will be one of the refracted parts of the beam, and OM will be the other part. It is found by experience, that the first or most refracted part OL is always *regular* in its refraction, or that its sine of refraction EK is in the constant proportion of three to five to the sine of incidence AD, however the angle of incidence AOB may vary.

But the other part of the beam OM is refracted in an irregular and uncertain manner, as is also found by experience. We shall, therefore, for the future, speak of the refraction of *Island Crystal* as distinguished into two kinds, *regular* and *irregular*.

When two pieces of crystal are placed one over the other, and in similar positions, that is, with their planes of perpendicular refraction FCGH, *f c g h*, parallel to each other (Fig. 4.), then an incident ray A B is refracted through the first regularly in the beam B D, and irregularly into the beam B E, as before has been said. At the nether surface F H of the first piece, the two rays will be refracted into two others DK and EI parallel to each other, and to the incident ray AB.

In this state they fall upon the lower piece *f c g h*, and are refracted through it without further division; but the ray KL is refracted in the regular manner, and the ray IM in the irregular one, and at the lower surface *f h*, they are both refracted into the air parallel to each other, as before. And this would be constantly the case with any number of crystals placed in like manner.

If the two pieces are so posited, that the planes of perpendicular refraction are at right angles with each other, then the ray KL, which before was refracted regularly, will, in this case, suffer an irregular refraction: and the ray IN before irregular, will now be regularly refracted through the lowest crystal, but still they pass singly through it.

" If one of these two pieces has its position inverted, or *hf* placed upwards, then will the ray IE be refracted to L, parallel to BD; and DK will be refracted to the same point L, in a direction parallel to BE in the first piece; and, consequently, by two pieces of crystal in such positions, no image of any object can appear double.

" In all other positions of the refracting planes besides those now mentioned, the rays DK, EI, will be separated each of them into *two*, in passing through the lower crystal; and, therefore, any object seen through two crystals so posited will appear *quadruple*, or will have four images.

" These are the principal properties of Island crystal enumerated by Hugenius, and from him by Sir Isaac Newton. But neither of them say a word of any *colorific refraction* in Island crystal, nor mention any thing more than a *double refraction*, and that through *parallel* surfaces only *. But this substance has still many, and much more wonderful properties, than those above mentioned, and are commonly known; for Island crystal has a much stronger *colorific refraction* than glass; and it is no wonder, since its refracting power is so much greater, being, as we have said, in the ratio of *five* to *three*, whereas that of glass is but as *three* to *two*.

" Though Island crystal is of a *talky* nature, and much softer than glass, yet it will take a polish little inferior to that of glass; at least it answers for all purposes and experiments of prisms, several of which I have made, and shewn in my public lectures for many years past.

* Bartholinus observed the *sextuple* refraction (See his *Exp. Crystall. Island.* p. 39. Exp. xi.); and Huygens noticed the *colours* in the supposed fissures, parallel to the long diagonal. See his *Traité de La Lumiere*, p. 95 —ED.

" By these prisms it appears, that there is not only a *double* but a *multuple refraction* in Island crystal; for some of these prisms held in a beam of the sun's light, will separate into *two* only, each of which produces a coloured *spectrum* of the sun much larger, and the colours more vivid than in those of glass prisms of the same refracting angle. And the refraction is so nearly equal in the two beams, that scarce any difference can be seen in the coloured images they make of the sun, a candle, or other object.

" Again, some prisms separate the solar ray into *four parts*, or particular beams of coloured light, which make *four spectrums* of the sun, all nearly equally coloured and strong. These prisms make every object seen through them appear *four*, and each one coloured, as in a glass prism.

" Some other pieces of Island crystal afford prisms with a *sextuple power of refraction*; for they will divide a beam of the sun's light into six *separate coloured beams*, and consequently shew as many coloured images of the sun, and of luminous bodies viewed through them. But these pieces of crystal are not very common; I have seen but one that was clear enough to make a good prism.

" The extraordinary refractions of these different prisms are represented in Fig. 5, 6, 7.

" In Fig. 5, through a small hole H in a window-shut ABCD, a beam of the sun's light HE is transmitted to the prism of Island crystal *abc*, and is thereby separated into two parts EF, EG; and these again refracted into the air, make the two diverging rays of light GI, FK, in all the different degrees of refrangibility; and these paint the two images of the sun I, K, in colours very intense and lively.

" The same beam of light HE in Fig. 6. is divided into *four*, and these produce *four* very beautiful *spectra*, and all of an equal degree of light and tints, nearly as at I, K, L, and M.

" In Fig. 7, the same beam is divided into *six* others, which depict six coloured images of the sun upon a screen; and notwithstanding the same quantity of light is now divided into six coloured *spectra*, which, in a glass prism of the same refracting angle, would make but one, yet it is surprising to observe how strong each spectrum appears in regard both to brightness and colour, and how little it falls short of that in glass.

"And what is still more very remarkable, is, that the *same piece* of Island crystal formed into two prisms, with angles nearly equal, will shew through one angle *two images* only; but through the other, it will exhibit *six*.

"I have not been able yet to procure Prisms of Island crystal of more than a *sextuple*, or sixfold refraction, singly used; but if two prisms are combined or placed together, so as either to increase the refracting angle, or diminish it, they become a *multiplier* and a *multiplicand*, and produce a *number of images*, according to the number in each singly.

"Thus, if one prism of two images, and a refracting angle of 35°, be applied to another prism of two images, whose refracting angle is 20°, the compound prism will then have an angle of 65° or 15°, as you please; but in each there will be *four images*, stronger or fainter, in proportion to the compound refracting angle.

"In like manner, if a prism of two images be properly compounded with a prism of four, there will result a prism of *eight images*, all very distinct, with colours more or less intense, according to the quantity of the compound refracting angle.

"Hence also a prism of two images applied to one of six, will produce a prism of *twelve images*. Again, two prisms of four images each, make a compound prism of sixteen images. And a prism of *four* applied to a prism of *six*, produces a prism of twenty-four images. Lastly, two prisms of *six images* each, compose one that will exhibit *thirty-six images*.

"We have mention made of a *double chromatic refraction* of a prism made of *mountain crystal*, or *crystal of the rock*, by Father Beccaria, in *Phil. Trans.* for the year 1762, p. 486. But he says it agrees in no respect but *number*, with the refraction of Island crystal; hence it is plain, this great *virtuoso* never saw a *prism of Island crystal*; for if he had, it would soon have convinced him of its great superiority, both in regard of its refractive power and chromatic quality.

"But the most extraordinary of all the strange properties of Island crystal is next to be rehearsed. It has been a maxim generally adopted by all optical writers, *that a parallelopiped of any diaphanous substance, having the refracting power equal upon each of its opposite and parallel sides, must there-*

fore refract the rays of light without sensible colour. But this general law does not hold in Island crystal, as we shall now demonstrate by experiment.

In Fig. 3, let PO be a beam of the solar rays, incident upon the first surface CG of the crystal in a dark room, then will it be divided into two, viz. OL, OM, as has been said; at the opposite and parallel surface FH, there will be another *double but very different sort of refraction* of each of the said two rays at L and M; for part of the ray OL will be equally refracted into LQ, parallel to the incident ray OP, after the usual manner in glass, &c.; but the other part of the said ray OL will be unequally refracted from L towards T, as they are in a prism, according to their different degrees of refrangibility; and therefore all the beam LT will appear of various coloured light in the darkened room. After the same manner, on the other part, the beam OM will be equally and unequally refracted into the two parts MR, parallel to PO; and MS of coloured light diverging from the point M.

" By these three beams refracted from the second surface of the crystal, there will be three different images of the hole at P, through which the first beam enters the room; for by the rays refracted in the usual manner in LQ and MR, the hole will have a *double* image at Q and R on the screen, but entirely *colourless*, at the distance equal to LM, in the corresponding parts, from each other.

" But the other two rays LT, MS, paint each of them a *coloured image* of the hole in the shutter, at such a distance on either side, as makes the angles TLQ, RMS, of about five or six degrees; and this different refrangibility of rays is strictly agreeable to that in glass, but in a greater degree, as before observed. By variously inclining the surface to the incident ray, the angle of refraction may, on each side, be varied from two or three degrees to sixty or seventy.

" As these pieces of crystal make three images, in a right line in the plane of perpendicular refraction FCGH, and that in the middle is double; so other pieces are found, by which this line of three images is refracted on each side into another line of three images, and the middle line of images is doubled; so that, upon the whole, there are no less than *twelve distinct*

images of the whole of the window-shut, formed upon the screen by twelve separate rays of light, regularly refracted through the crystal terminated by parallel sides.

" But that this most amazing of all optical phenomena may be more clearly apprehended, I have represented it to the eye in Fig. 9, where the images at 1, 2, 3, are those in the line just mentioned, and which, in the present piece of crystal, becomes doubled in the images 4, 5, and 6. This line is refracted also *sideway*, so as to form three other images on each side, as at 7, 8, and 9, above; and at 10, 11, and 12, below; and all in so regular a manner, as to form the mathematical figure or *rhombus*, every way similar to that of the plane of perpendicular refraction CFHG.

" These images are all of them tinged with variety of colours, except the two central ones at 2, and 5, which appear nearly as white as before. They are not equally coloured, however, for some are almost wholly red, others yellow, others green, blue, or violet, according as you vary the inclination of the surface to the incident ray. The two images at 9, and 10, in the acute acute angles are very faint, and, unless the object be very bright, cannot be seen, as the *sun*, a *candle*, &c.

" If you turn the crystal round an axis, the whole system of images moves round with it, as in other cases; constantly with the red part of each image towards the central hole or beam, and the violet the most remote from it.

" If prisms of two, four, or six images be successively applied to the parallelopiped of crystal, they will multiply the number of images accordingly in the rhombus, and produce the number *twenty-four*, *forty-eight*, and *seventy-two images* of the sun or a candle; the greatest part of which will be very distinct, and completely tinged with regular prismatic colours, so as to compose a kind of natural *girandole* of *painted luminaries*, infinitely exceeding any production or imitation by the art of glass.

" Besides these now recounted, there are other, and perhaps more strange refractions of Island crystal; but to give a detail of all the properties that may be observed in this substance, and the multifarious manner in which it acts upon light, would be very tedious; especially as I cannot account for any of those already related upon the *common principles of optics*. Some pe-

culiar structure of the parts of Island crystal, yet unobserved, or some particular modification of the particles of light which Sir Isaac Newton himself was not apprised of, must certainly make a part of their latent cause. How far those numerous fine *fissures* which may be seen in some polished pieces, whose planes are all at right angles to the plane of perpendicular refraction FCGH, and have the same inclination with the line CF, and which are beautifully distinguished by rings of coloured light; I say, how far such *fissures* may be concerned in producing such a diversity of refracting properties, must be left to future inquiry; only it may be observed, that each fissure severs from the parallelopiped an *equiangular prism*, whose base is similar to the equilateral triangle FL*g*, and its refracting angles equal to FL*g* or F*g*L, viz. 39° 4'. (See Fig. 1.)

"As these *fissures* have never been mentioned by Hugenius or Newton, and as I have met with but one piece that will show them very plain and distinctly, in order that some idea may be formed of them, they are represented in Fig. 8. by the several *dotted parallel lines*, such as their intersections appear to make with the surface of the crystal; and at right angles to the plane of refraction DE."

(*To be continued.*)

Art. XXIV.—*On the Construction of Polyzonal Lenses and Mirrors of great magnitude, for Light Houses and for Burning Instruments, and on the formation of a great National Burning Apparatus.* By David Brewster, LL.D. F.R.S. Lond., and Sec. R. S. Edin.

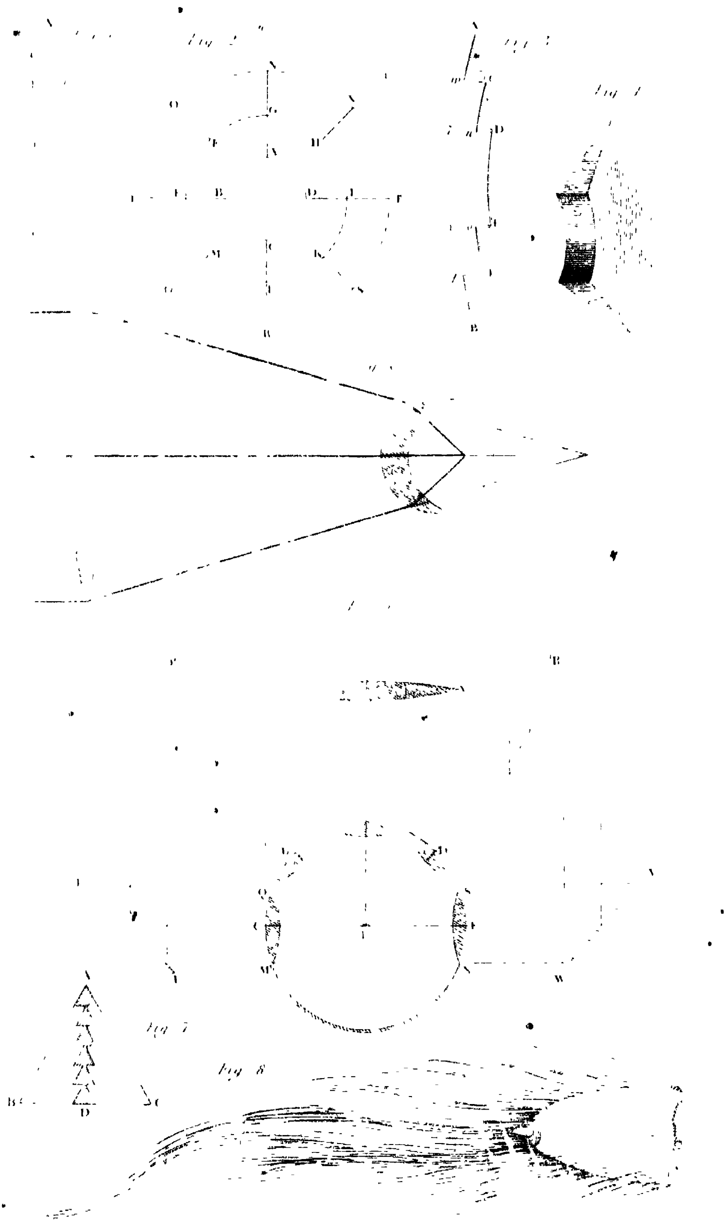
In the year 1811, I had occasion to pay particular attention to the construction of lenses and mirrors, of a large size, for the purpose of burning, and in the year 1812, I published the results of my inquiries in the Article Burning Instruments, in the Edinburgh Encyclopædia.

The obstacles which are opposed to the construction and use of lenses, of a large size, arise,

1. From the difficulty of casting, grinding, and polishing them.

PLATE IV.

Edin. Phil. Journ. Vol. VIII. p. [illegible]



Published by A. Constable & Co. Edin. 18[illegible]

2. From the difficulty of procuring such a large mass of glass free from imperfections; and,
3. From the great thickness which is necessary at the centre of a large lens, in consequence of which a very considerable quantity of light and heat is absorbed, and scattered, by the numerous veins and imperfections which occur in such a thickness of transparent matter.

The celebrated Buffon proposed to remedy the last of these evils by what he calls *Lentilles en echelons*, or lenses with steps, as shewn in Plate IV. Fig. 1., where the lens ACDEFGB*gfedc*, consisting of one piece of glass, will produce the same effect as the lens AC*m*Gb*gnc*, and yet does not contain one-half the quantity of glass. The difficulty, however, of grinding the surfaces CD, DEF, EG, &c., independently of the difficulties above enumerated, rendered it impossible to execute such lenses on a large scale, so that the idea of M. Buffon must be considered as one of those ingenious but visionary speculations which never terminate in practical utility *.

In the year 1811, the idea occurred to me of constructing large lenses of *many zones* or *rings*, and of composing each zone of separate segments, so that a lens of any magnitude might be *built*, as it were, of separate pieces; and in 1812, I published, in the article already quoted, the following method of construction †.

" In order to remove these evils, and at the same time to diminish the expence, and simplify the construction of dioptric burning instruments, the following construction has been proposed by Dr Brewster. If it be required, for example, to construct a burning lens 4 feet in diameter, it should be composed of different pieces, as represented in Plate IV. Fig. 2., where ABCD is a lens of flint-glass, 18 inches in diameter. This lens is surrounded by several segments, AGID, AGEB, BELC, CLID, ground in the same tool with ABCD, but so formed with respect to their thickness at AB and GE, &c. that they may exactly resemble the corresponding portions of a solid lens. These

* It is quite certain that Buffon constructed a lens of one piece of glass from 12 to 15 inches in diameter, according to this principle.

† This mode of constructing lenses is also referred to in my *Treatise on New Phil. Instruments*, Edin. 1813, p. 399, Note.

different thicknesses can be easily calculated, and there is no difficulty in giving the segments their proper form. This zone, consisting of separate segments, is again surrounded with other segments, GNOF, FOEP, PEMQ, QMLR, RLKS, SKIT, TIHV, VHGN, each of which is six inches broad in the direction of the radius. The section of this lens is represented in Fig. 3. where DE is the central portion, DC*n*, E*o*F the second zone, and CA*m*, FB*p* the external zone. One of the segments is shewn separately in Fig. 4. By this combination of segments, a lens four feet in diameter will be formed, and will obviously possess the same properties as if it consisted of solid glass. The advantages of this construction may be very shortly enumerated.

"1. The difficulty of procuring a mass of flint glass proper for a solid lens, is in this construction completely removed.

2. "If impurities exist in the glass of any of the spherical segments, or if an accident happens to any of them, it can be easily replaced at a very trifling expence. Hence the spherical segments may be made of glass much more pure and free from flaws and veins than the corresponding portions of a solid lens.

"3. From the spherical aberration of a convex lens, the focus of the outer portion is nearer the lens than the focus of the central parts, and therefore the solar light is not concentrated in the same point of the axis. This evil may, in a great measure, be removed in the present construction, by placing the different zones in such a manner that their foci may coincide.

"4. A lens of this construction may be formed by degrees, according to the convenience and means of the artist. One zone, or even one segment, may be added after another, and, at every step, the instrument may be used as if it were complete. Thus, in Fig. 2. the segment NV*vn* may be added to the lens, without the rest of the zone to which it belongs, and it will contribute, in the proportion of its area, to increase the general effect.

"5. If it should be thought advisable to grind the segments separately, or two by two, a much smaller tool will be necessary than if they formed one continuous lens. But, if it should be reckoned more accurate to grind each zone by itself, then the various segments may be easily held together by a firm cement.

"6. Each zone may have a different focal length, and may therefore be placed at different distances from the focal point, if it is thought proper."

For the purpose of applying these, or lenses of any form to produce powerful effects as burning instruments, I proposed the subsequent combination, under the name of a *Burning Sphere.* The following is the passage from the Encyclopædia:

"In order to construct a burning instrument which shall, in a great measure, be unlimited in its power, we must combine the principles both of reflection and refraction. We are not aware that any instrument of this kind has ever been proposed; and we are the more surprised at this, as the proper combination of lenses and mirrors must naturally suggest itself to any one who considers the limits which are set to the construction of single lenses, and the disadvantages, either of a theoretical or a practical nature, to which they are liable.

"This instrument, which has been proposed by Dr Brewster, and which may properly be called a burning sphere, from the arrangement of the lenses, is represented in Plate IV. Fig. 5. which is merely a section of the sphere, and represents only five of the lenses, and four of the mirrors. The lenses A, B, C, D, E, which may be of any diameter and focal length, are so placed in the spherical surface AMN, that their principal foci exactly coincide in the point F. If any of the lenses have a different focal length from the rest, the coincidence of its focus with that of the other may be easily effected, by varying its distance from F. The whole spherical surface, whose section is AMN, except a small opening for admitting the objects to be fused, may be covered with lenses, having all their foci coincident at F; though it will, perhaps, be more convenient to have the posterior part MN without lenses, and occupied by a mirror of nearly the same radius FA as the sphere. The object of this mirror, is to throw back upon the object at F the light that passes by it without producing any effect. Each of the lenses, except the lens A, is furnished with a plane glass mirror, which may be either fixed to the general frame of the sphere, or placed upon a separate stand. When this combination is completed, the sphere is exposed to the sun, so that its rays may fall at right angles upon the lens A, which will, of course, concentrate them at F, and produce a pretty intense heat. The plane mirror PQ, when properly adjusted, will reflect the sun's light perpendicularly upon the lens B, by which it will be refracted accurately to the focus

F, and produce a degree of heat fully one-half of what was produced by the direct refracted rays of the sun through the lens A. A similar effect will be produced by the mirror RS and lens D, the mirror TU and lens C, the mirror VW and lens E, and by all the other mirrors and lenses which are not seen in the section. The effect may be still farther increased by the addition of a large lens at X, X. As the angle which the surface of each mirror forms with the axis of its corresponding lens is a constant quantity, the mirrors may be all fixed to the general frame of the sphere, and therefore the only adjustment which the instrument will require, is to keep the axis of the lens A parallel to the direction of the solar rays.

" In order to estimate the advantages of this construction, let us compare its effects with those of a solid lens, which exposes the same area of glass to the incident rays.

" 1. In the burning sphere, almost the only diminution of light is that which arises from reflection by the plane mirrors, and which may be estimated pretty accurately at one-half of the incident light; but this loss can be amply compensated by adding a few more lenses.

" 2. In the solid lens, a great diminution of light arises from the thickness of the central portions, and from the obliquity of the parts at the circumference; which, we conceive, will be fully equal to the light lost by reflection in the burning sphere.

" 3. In the burning sphere, the lenses may be obtained of much purer glass than can be got for a solid lens; and therefore, *cæteris paribus*, they will transmit more light.

" 4. Owing to the small size of each lens in the burning sphere, the diminution of effect arising both from spherical aberration and from the aberration of colour, will be very much less than in the solid lens.

" 5. In the burning sphere, the effect is greatly increased, in consequence of the shortness of the focal length of each lens, and the greater concentration of the incident light.

" 6. In the burning sphere, all kinds of lenses may be combined. They may be made of any kind of glass, of any diameter and of any focal length; *and the lenses belonging to different individuals may be combined for any occasional experiment, in which a great intensity of heat is requisite.*"

Lenses have been long used in England* for the purposes of illumination in light-houses; and in 1818 or 1820, some experiments had been made with them in France, in connection with a very powerful lamp, the particulars of which were communicated by Major Colby to Mr Robert Stevenson, Engineer to the Northern or Scotch Light-House Board. On the receipt of this letter, Mr Stevenson, ever anxious for improvements, communicated to me his intention of investigating the subject in reference to the use of lenses in light-houses. I immediately pointed out to him the improvements in the construction of lenses, and the method of arranging them for the purpose of illumination, (which is just the converse of the arrangement for combustion), that I had suggested in the Edinburgh Encyclopædia; and he proposed that we should make some experiments, with the view of introducing them into the Northern Light-Houses. Before proceeding, however, to this inquiry, he was anxious to obtain an account of what had been done in France; and as it was afterwards understood that the Corduan Light on the coast of France was to be fitted up with lenses, Mr Stevenson's intention was to make personal observations upon it, whenever the alterations on that light-house should be completed.

About a fortnight ago. however, Mr Stevenson and I received copies of a Memoir by M. Fresnel, (already celebrated by his optical discoveries), read at the meeting of the Academy of Sciences, on the 29th July 1822, and entitled "*Memoire sur un Nouveaux Systeme d'Eclairage des Phares.*"

The method described in this Memoir, consists in using large lenses, built of separate pieces, in the same manner as those which I proposed *ten* years ago, and the plan of combining them with reflectors is also similar to that which is above described.

In making this claim to the invention of polyzonal lenses, it will not be understood that I mean to throw any blame upon M. Fresnel, for not having made a reference to the article in which it is contained. I am quite satisfied that this distinguished philosopher never saw the work in which it is published, and that he will be the first to acknowledge the priority of my labours.

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* Lenses *twenty-two* inches in diameter, are employed in the lower light-house in the Isle of Portland, erected in 1789.

It has been already stated in the preceding extract, that the spherical aberration of the lens may be nearly corrected by a proper adjustment of the zones. By examining Fig. 3., indeed, it will be obvious, that a lens constructed exactly like it, will have less spherical aberration than if the lens were in a solid state, provided the parallel rays are incident on the continuous face ADEB. For since the focus of the central portion is always more remote from the lens than the focus of the contiguous zone, the focus of the thin lens DE, will be nearer the lens AB than the focus of the corresponding portion D δ ϵ E in the solid lens, and consequently the breadth of the zones may be so adjusted that the mean focus of each shall coincide in the axis of the lens without displacing them from their virtual position in the solid lens, that is, without breaking the continuity ACDEF of their common surface. This curious property of diminishing the spherical aberration, does not belong to the method of forming the steps adopted by Buffon; and M. Fresnel, in whose lenses the steps have the same position as in those of Buffon, seems also to have overlooked it.

If good and colourless flint-glass could be procured for the segments of each zone, the lens might be built without steps, or of the solid form A m p B, if solidity should be considered requisite, when its magnitude is to be very great; though even in this case sufficient strength might be obtained, without resorting to such an alternative.

The spherical aberration in polyzonal lenses might also be removed by using zones of different refractive powers, the densest being placed in the centre, thus imitating in a coarse manner the crystalline lenses of animals; or the same effect might be produced by a slight increase in the focal length of the zones as they recede from the centre.

In all these cases, however, the directions of the bases m C, n D, o E and p F of the zones, should converge to the focus of rays refracted at the first surface of the lens.

The principles which have now been described in reference to the formation of lenses, are equally applicable to *Polyzonal Mirrors* of a large size, which may be constructed of any magnitude, and the successive zones so adjusted as to produce a perfect coincidence of the mean focus of each zone.

In my *Treatise on New Philosophical Instruments* (p. 399.

Note), I have long ago suggested the application of these views even to lenses of flint-glass, for the most delicate purposes in optics; and there is some reason for expecting that lenses with steps, either in a solid state, or composed of zones and segments, and solid lenses built with separate pieces of glass, of the same refractive power, or with zones of variable density, will speedily be introduced into actual use *.

The great superiority of lenses over mirrors, for the purposes either of fixed or moveable lights in light-houses, is so manifest, that we expect to see them replacing the parabolic reflectors in all our light-houses; but when we consider the scientific results which are likely to be obtained from improved burning instruments, too much labour cannot be bestowed in bringing them to perfection.

"The formation of instruments for burning at short distances," as I have remarked in the work already quoted (*Edinburgh Encyclopædia*, vol. v. p. 139.), "is a subject of the first importance to science, and we have no doubt that they will, some time or other, be employed as the most powerful agents in chemistry and the arts. Though catoptric burning instruments of great power have been constructed, yet their effects have never been so great as those of lenses, and they are besides liable to numerous disadvantages. The burning point must evidently lie between the centre of the mirror and the sun, and, therefore, the operator cannot so easily perform his experiments, as when the focus lies on the other side of the instrument. All his operations, indeed, have a tendency to obstruct the light before it falls upon the reflecting surface. This evil will not admit of a remedy, and consequently we must have recourse to instruments of a dioptric or catadioptric nature, which are alone capable of uniting great power with great facility of management."

In constructing a burning apparatus with a large lens, it has been found advantageous to use a *second lens* to receive and concentrate the converging rays from the principal lens. This, we believe, was first proposed by M. Tschirnhausen, and was

* The same principle is applicable to the construction of large prisms for optical experiments, as shewn in Fig. 7, where the same effect may be produced by the six small prisms AD, as by the whole prism ABC. These *six* prisms may be all ground in one prismatic rod, which may be cut into small prisms when polished.

adopted in the great burning lens of Parker, 32 inches in diameter; but in the polyzonal burning lenses we may avail ourselves of the second lens with peculiar effect, by giving it the form of a meniscus (See Fig. 6.), which, though bounded by spherical surfaces, has the singular property of converging homogeneous rays to a mathematical point, provided the distance of the focus of the great burning glass from the centre of the first surface of the small lens is to the radius of the first surface as the Sine of the angle of incidence is to the Sine of the angle of refraction. The aberration of the principal lens being almost removed by its polyzonal construction, and the second glass entirely free of that source of error, we may expect from such an apparatus effects of the most powerful kind *.

The munificence of Sovereigns and of public Societies, has been so frequently displayed during the last century, in the construction of instruments, beyond the reach of individual zeal, that we cannot omit the present opportunity of suggesting the formation of a National Burning Apparatus, to the construction of which all the scientific institutions in the kingdom might contribute. Each society, for example, might undertake the formation of a single zone of the national lens, which zone would of itself be an useful burning glass, and might be afterwards completed when the society's funds enable it to do so. These numerous zones might then be combined for the purpose of occasional experiments, under the direction of our most distinguished philosophers, and we cannot doubt but that discoveries would thus be made which would form an epoch in the history of the arts and sciences. The fusion and combination of refractory materials could not fail to produce the most interesting compounds, and create processes in the useful arts of which we can at present form no conception. The reduction to fluidity of simple and compound minerals, and the phenomena exhibited by their union, and by their slow cooling, would throw the clearest light on many of the most perplexing questions in geology, while every branch of general physics would derive new resources from the energy of such an irresistible agent.

The expence of a polyzonal apparatus *five* or *six* feet in diameter, even in the more compound form of the *Burning Sphere*.

* The meniscus may form one side of a glass sphere for holding the products of combustion, as shewn in Fig. 6.

could not much exceed L. 300 *, and we are confident that the public spirited individual who should advance such a sum for the interests of science, would do more for its progress, and acquire more reputation, than if he were the author of the most splendid discovery.

Art. XXV.—*Account of the recent successful Ascent of Mont Blanc*, by Mr F. Clissold.

The following interesting account † of Mr Clissold's ascent of Mont Blanc, was transmitted to us by our friend Professor Pictet, through the hands of Mr Clissold himself, who has accompanied it with some important corrections.

We are glad to learn, that Mr Clissold has resolved, contrary to his original intention, to draw up a short account of his ascent, and we trust he will enter into the minutest details on a subject so extremely interesting. Mr Clissold has very handsomely resolved to transmit to Professor Pictet, any profits that may arise from the publication of his narrative, for the benefit of the families of the three guides who perished in the unsuccessful attempt of 1820.

"Since the unfortunate ascent in which three guides of Chamouny perished, on the 18th of August 1820, not far from the summit of Mont Blanc, being precipitated and buried in a cleft by an avalanche of snow, nobody had attempted this enterprise, which is as dangerous as it is useless, till a young English gentleman (Mr F. Clissold) came from London to Chamouny with the firm resolution of attempting it. After having spent the first half of August at the foot of this formidable mountain, in expectation of favourable weather, he at last executed the ascent, on the 19th of August, with a success, and, above all, a celerity, of which none of the nine preceding ascents afford an example. He has transmitted some particulars of his expedition, in a letter to his banker, who has had the goodness to communicate it to us, and which the author himself, whom we have had the satisfaction of

* Parker's solid lens of 32 inches, now in the possession of the Emperor of China, cost L. 700.

† Printed in the *Bibliothèque Universelle*, Septembre 1822.

conversing with more than once, after his return to Geneva, has allowed us to insert in our work.

"*Chamouny, August* 27. 1822.—Sir, You have probably heard of the success of my ascent of Mont Blanc, of which I shall communicate to you some particulars. I left Chamouny, where I remained fifteen days in expectation of settled weather, on Sunday, the 18th, at half past 10 P. M., with six chosen guides, one of whom was provided with a lantern *. We ascended, as is usually done, by the mountain called *De la Cote*, and reached the summit of it at half past three in the morning. After a short halt, we entered, at four o'clock, on the Glacier; and, having crossed it without accident, reached, at half past seven, the rocks called the *Grands Mulets*, where preceding travellers have generally made arrangements for passing the night. My plan was different: I was ambitious to reach the summit the same day, and to remain there during the night, in order to see the day-break on the following morning. We therefore continued our march, the most difficult part of which was in the neighbourhood of these same rocks, where we had to climb obliquely up a very steep slope of ice, inclined about 45 degrees, in which we were obliged to cut with a hatchet a number of steps, the missing of one of which would have been certain death; for this slope terminated at an enormous cleft. This passage was still worse when we came down again. We quitted the *Grands Mulets* at nine o'clock, and reached at two the *Grand Plateau*, near the *Dôme du Gouté*. We were in the region of those masses of snow, which are formed into enormous parallelopipedons, called *Seracs*. Thence, ascending to the left, we from time to time proceeded along the edge of the clefts, one of which was perhaps the grave of the victims of 1820. All the guides, excepting P. M. Favret, and myself, were more or less incommoded by the rarefaction of the air. Three of them, in particular, who ascended Mont Blanc for the first time, lost their strength to such a degree that they considerably delayed our progress. If it had not been imprudent to separate, I should certainly have reached the summit before night. We arrived about seven in

* Each of these guides carried a weight of 20 lb. in provisions and objects of precaution for the ascent. Mr Clissold, either with the design of trying his strength, or with the view of inspiring the guides with confidence, carried one of these loads during a considerable part of the ascent of the mountain De la Cote.

the evening at the *Petit Mulet*, a rock situated above the *Rocher Rouge*, the nearest to the top of all those that are seen from Chamouny. We had reached it at half past six. The *Petit Mulet* being higher, and to the left, is not visible from below. As we had not time to reach the summit before night, we descended again to the *Rocher Rouge*, near which we made a pit in the snow, four feet deep, five broad, and six long. We placed at the bottom some pieces of wood, on which we spread a rather thin covering, on which we all seven lay down, covered with a slight sheet, which was by no means sufficiently large for the purpose. Some blasts of wind, which now and then blew into our faces some of the light snow drifted from the surface, was a bad omen of the fate that awaited us if the wind had risen. We slept, however, about four hours. We could not observe the thermometer for want of light; but the night was cold enough to produce ice in a bottle of Hermitage wine, and thoroughly to freeze some lemons among our provisions. The right foot of one of my guides (David Coutet) was frozen, and also the extremities of my own fingers and toes. But these accidents were attended with no bad consequences. We left our cold couch at four o'clock in the morning. The day was beginning to break, and the first rays of the dawn gave a silver tinge to the summits, from which we were not far distant. In proportion as the sun approached the horizon, the tint changed, and became entirely golden when he rose. It formed the most striking contrast with the nearly black colour of the sky, from which it seemed to be detached. All the difficulties were now surmounted: we sunk but little in the snow, and now and then halted for a short time to take breath. We soon came to the *Petit Mulet*, which we had visited the day before; and at half past five we were on the summit. We began by making the signals agreed on with our friends in the plain, who easily distinguished them.

"This summit is not so limited as it seems to be at a distance. It forms a small plain, nearly horizontal *, which is in the shape of a triangle, the base of which is towards Chamouny; one side is towards the *Allée Blanche*, and the other towards the passage of *Bon-homme*. It took me four minutes to walk along the perpendicular drawn from the apex of the triangle to the base.

* About 200 feet fall, (F. C.)

"The sky was without clouds; the sun, which had risen below our horizon, deluged with light the region from which it seemed to issue, and in the direction of which we could distinguish nothing. Every where else we perceived a vast number of summits, some covered with shining ice, others more or less rent and threatening: others, again, of roundish forms, and covered with pasture. Jura bounded the horizon in the N.W.; more to the north we saw the lake, but not Geneva. To the S.E. the eye penetrated beyond the Plains of Lombardy, as far as the Apennines, which bounded the horizon in the form of a blue line, or of the dense fog of a winter's morning. The sun, both at setting the preceding evening, and at rising in the morning, seemed more or less enveloped in this vapour. I had brought no instrument with me but a thermometer. At sun-set the day before, near the *Rocher Rouge*, it was at 26° Fahrenheit. We forgot to observe it when we set out in the morning; but Coutet, who is used to make observations at great heights, thinks that the cold exceeds 18° Fahrenheit. But on the summit at eight o'clock; at the *Grands Mulets*, the day before, at nine; and the *Grand Plateau*, the same day, at three; lastly, at the *Grands Mulets* the next day (Tuesday, about three in the afternoon);—at all those stations the thermometer observed by Coutet, and one at four or five feet from the ground, stood at 70° Fahrenheit.

"During our stay on this singular *belvedere*, some of the guides picked up specimens of the highest rocks near the summit, which I brought along with me. After stopping three hours on the summit, where I felt myself very comfortable, except that I had lost my appetite since leaving the *Grands Mulets*, though the guides had preserved theirs, we set out for the purpose of descending. It was half past eight o'clock. At eleven, we came to the *Grand Plateau*, and at half past one to the *Grands Mulets*. When we arrived there, we heard something like the rolling of thunder, which was nothing but the noise of an enormous avalanche, which was seen from the *Col de Balme*, to cover a part of the space which we had crossed in our descent. A few hours sooner, and we should have all been enveloped and destroyed.

"We quitted the *Grands Mulets* at three o'clock, and at half past three were beyond the region of the ice. We arrived

at the Priory of Chamouny at half past seven, after an absence of forty-five hours.

"We there heard that two English ladies (Mrs and Miss Campbell) had passed the Col du Geant, two or three hours before we reached the *Petit Mulet*, and that while we were near that rock, they were descending at Cormayeur. They had left Chaumony on Sunday, and spent the night at the foot of the rocks of Tacul. In consequence of the ignorance of their guides, they met with more difficulties than I experienced. They are resolved to attempt, next year, or the year following, the ascent of Mont Blanc.

"I owe so much of my success to Joseph Marie Coutet, that I wish to present him with a portable barometer, made by your excellent artist M. Gourdon, and I beg that you will endeavour to obtain it for him as soon as possible.

"I am much indebted to you for having procured me the acquaintance of M. De Saussure, and the inspection of the shoes which his late father wore at the time of his ascent. I got mine made upon the very same plan, and they enabled me to cross rapidly the Glacier of Boissons, and to pass where the guides could not follow me. I walked, indeed, with these shoes upon the hardest ice, as if I had been upon the solid ground *."

The following are the names of my guides:

Joseph Marie Coutet, the chief. This was his sixth ascent.
David Coutet, his brother. This was his fourth ascent.
Pierre Marie Favret, the strongest of them all. This was his third ascent. His father formerly ascended with Saussure.
Jacques Coutet, another brother of Joseph. }
J. Baptiste Simon. } This was their first ascent.
Matthieu Bossnet. }

Note by Prof. Pictet, *on the Specimens from Mont-Blanc.*

Mr Clissold has had the goodness to shew us his specimens, and give us duplicates of the most interesting.

* These shoes have the soles sufficiently thick to receive nails of steel, cut with a square point, and the other end of which has a screw, which is fixed in the leather, on which rests the base of the pyramid, which forms the head of the nail. The steel is tempered, and brought back to a straw colour, which leaves it almost all its hardness, and renders it less liable to break.

No. 1. Is the fragment of a rock *in situ*, nearest the summit, that is, the highest point of Europe. It is an amorphous rock, in which feldspar predominates, mixed with a little quartz. It is yellow here and there with oxide of iron.

No. 2. Is a specimen of those rocks with vitreous bubbles on the surface, which are commonly found on the Aiguille of Gouté, and of which Mr Clissold has brought a great number from the summit of Mont Blanc. The one in question is composed of a mass of black amphibole (hornblende), almost pure, to which adheres a distinct crystal of feldspar. At the place where the two substances come in contact, are seen three or four globules of black glass, one of which is about a line and a half in diameter, and from this runs a slight groove, excavated out of the feldspar portion of the stone, and in which there are small globules of black glass, an effect which seems to confirm the opinion of those who attribute these fusions to lightning *.

No. 3. Is a small specimen of the same kind of rock, but in which the feldspar is more disseminated. Two faces of the stone are wholly covered with microscopic vitreous globules, and one of its two faces, seen with a microscope, appears entirely covered with a varnish arising from fusion.

No. 4. Is a fragment of rock of the *Grands Mulets*, covered with small crystals of Adularia, intermixed with Amianthus †.

Art. XXVI.—*On the Visible Solar and Lunar Eclipses which will happen in the year* 1823, *as calculated for Edinburgh.* By Mr George Innes ‡.

In calculating the two lunar eclipses, I have increased the moon's equatorial parallax $\frac{1}{60}$th part, for the refraction of the

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* In our next Number we shall give an account of similar appearances observed on the summits of heaths on the Pyrenees, Riesengeberge and Andes.—Ed.

† Mr Clissold, we understand, means to deposit the greater part of the specimens in the British Museum, and in that of the Geological Society.—Ed.

‡ The times are inserted according to the Civil account, the day being reckoned to begin at midnight. The elements are calculated from the Tables of M. Delambre and M. Burckhardt.

earth's atmosphere. Astronomers seem doubtful how much is to be added to the semidiameter of the shadow of the earth, as projected at the distance of the moon; but the quantity must certainly bear some proportion to the parallax.

I send you the elements of the solar eclipse, for the use of such as may wish to make a projection; but from the instant of greatest obscuration falling between 5 and 6 o'clock, it will be found very difficult to determine, with sufficient accuracy, the distance of the corresponding points on the respective paths.

In reference to this eclipse, it will be interesting to observe whether any visible impression is made on the sun's limb, at those places which are situated about the extremity of the penumbra. Such places will be found a little to the west, southwest, and south of London.

The Elements of the Solar Eclipse are as follows:

	D.	H.	′	″
Mean time of Ecliptic Conjunction at Edinburgh, -	July 8.	6	32	4,79
Equation of *Mean* to *Apparent* time at conjunction, -		—	4	29,99
Hence the *Apparent time* of conjunction, is - -	8.	6	27	34,80
Longitude of the Sun and Moon, from true equinox, -		105	14	14,74
Sun's Right Ascension, - - - - -		106	32	19,62
—— Declination north decreasing, - -		22	35	30,6
—— horary motion in longitude, - -		0	2	23,00
—— —— —— — Right Ascension, - -		0	2	23,93
—— —— —— — Declination, - -		— 0	0	16,10
—— semidiameter, - - -		0	15	45,57
—— horizontal parallax, - - -		0	0	8,65
—— Latitude, - - -		+ 0	0	0,03
Horary increase of the equation of time, - -		0	0	0,396
Obliquity of the Ecliptic, - - -		23	27	49,76
Moon's Latitude North decreasing, - -		1	8	42,77
—— Equatorial horizontal parallax, - -		1	1	21,15
—— horizontal semidiameter, - -		0	16	42,12
—— horary motion in Longitude at conjunction, -		0	37	59,971
—— —— —— —— for the hour preceding,		0	38	0,072
—— —— —— —— for the hour following,		0	37	59,871
—— horary motion in Latitude at conjunction, -		0	3	25,886
—— —— —— —— for the hour preceding, -		0	3	25,610
—— —— —— —— for the hour following, -		0	3	26,162
Angle of the relative path with the Ecliptic, - -		5	50	12,5
Horary motion of the Moon from the Sun in the relative Orbit,		0	35	43,78

The following are the results which I have obtained in calculating for Edinburgh:

CALCULATION for Edinburgh Observatory;—Observed Lat. 55° 57′ 57″,0 N.; Long. in time, 12′ 41″,4 W.

		For the Beginning.		For Appar. Conj. and Greatest Ob.		For the End.	
		H. ′ ″	H. ′ ″	H. ′ ″	H. ′ ″	H. ′ ″	H. ′ ″
Instants assumed, July 8.		4 53 34,159	4 54 34,166	5 21 34,344	5 22 34,351	5 48 34,522	5 49 34,529
Sun's Longitude,		105° 10 30,707	105° 10 33,090	105 11 37,440	105° 11 39,823	105° 12 41,790	105° 12 44,173
—— Right Ascension,		106 28 34,130	106 28 36,529	106 29 41,297	106 29 43,696	106 30 46,066	106 30 48,461
Moon's true Longitude,		104 14 41,980	104 15 20,007	104 32 26,433	104 33 6,448	104 49 32,650	104 50 10,656
—— true Latitude,		1 14 1,493	1 13 58,150	1 12 27.201	1 12 23,829	1 10 55,647	1 10 52,251
Right Ascension of the Meridian,		359 52 6,5	0 7 9,0	6 53 16,5	7 8 19,0	13 39 23,9	13 54 26,4
Altitude of the Nonagesimal,		40 36 32,0	40 41 42,1	42 57 40.8	43 2 34,9	45 6 18,0	45 10 54,5
Longitude of the Nonagesimal,		30 16 20,0	30 26 38,3	35 1 32,6	35 11 39,5	39 32 52,0	39 42 51,1
Parallax in Longitude,	+	0 38 19,951	0 38 22,196	0 39 9,504	0 39 10,754	0 39 30,554	0 39 30,839
Parallax in Latitude,	—	0 46 16,375	0 46 12,721	0 44 34,387	0 44 37,773	0 42 57,384	0 42 53,836
Appar. diff. of Long. of the ☉ and ☽,		0 17 28,776	0 16 50,887	0 0 1,503	0 0 35,379	0 16 21,414	0 16 57,322
Moon's apparent Latitude, North,		0 27 45,118	0 27 45,126	0 27 52,814	0 27 53,069	0 27 58,263	0 27 58,415
—— apparent semidiameter,		0 16 45,29		0 16 46,99		0 16 48,62	
—— apparent motion from ☉ in 60″ of time,		0 0 19,665		0 0 36,882		0 0 18,502	
Errors from instants assumed, — too early, + too late,		—0 0 17,019	+0 0 2,616	—0 0 1,503	+0 0 35,379	—0 0 10,035	+0 0 8,467
Hence, The		Eclipse begins at 4h 54′ 26″,093		Appar. Conjunc. at 5h 21′ 36″,787		End of the Eclipse at 5h 49′ 7″,064	

The final results of the calculations are as follows:

EDINBURGH.

		Apparent Time.	Mean Time.
		H. ′ ″	H. ′ ″
The eclipse begins,	July 8.	4 54 26,09	4 58 55,39
Greatest obscuration,	-	5 21 18,01	5 25 47,49
Apparent conjunction,	-	5 21 36,79	5 26 6,26
End of the eclipse,	-	5 49 7,06	5 33 36,72

Digits eclipsed, 1 dig. 46′ 31″,98, on the north part of the Sun's disc. The Moon will make the first impression on the Sun's limb, at 8½° to the left of his zenith.

January 26. MOON eclipsed, partly visible:

EDINBURGH.

		Apparent Time.	Mean Time.
		H. ′ ″	H. ′ ″
The eclipse begins,	January 26.	15 12 4,9	15 24 56,0
Beginning of total darkness,	-	16 9 34,5	16 22 26,2
Moon rises,	- -	16 17 30,0	16 30 21,7
Ecliptic opposition,	-	16 58 1,7	17 10 53,8
Middle,	- -	16 58 47,9	17 11 40,0
End of total darkness,	-	17 48 1,3	18 0 53,8
End of the eclipse,	-	18 45 30,9	18 58 23,9

Digits eclipsed, 20 dig. 49′ 46″,9 from the north side of the Earth's shadow. The Moon's centre will pass 4′ 28″,0 North of the centre of the Earth's shadow, at the middle of the eclipse.

July 23. MOON eclipsed, partly visible:

EDINBURGH.

		Apparent Time.	Mean Time.
		H. ′ ″	H. ′ ″
The eclipse begins,	January 23.	1 16 54,4	1 22 57,1
Beginning of total darkness,	-	2 23 41,2	2 29 44,0
Middle,	- -	3 13 20,6	3 19 23,5
Ecliptic opposition,	- -	3 15 22,0	3 21 24,9
Moon sets,	- -	3 38 50,2	3 44 53,0
End of total darkness,	-	4 3 0,0	4 9 3,0
End of the eclipse,	- -	5 9 46,8	5 15 49,9

Digits eclipsed, 18 dig. 13′ 22″,1 from the North part of the Earth's shadow. The Moon's centre will pass 9′ 10″,9 North of the centre of the Earth's shadow, at the middle of the eclipse.

ABERDEEN, 8*th Nov*. 1822.

Art. XXVII.—*Celestial Phenomena, from January 1. to March 1. 1823, calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.

January.

D	H	′	″	
1.	23	13	8	Em. I. sat. ♃
3.	17	42	0	Em. I. sat. ♃
4.	4	2	53	☾ Last Quarter.
5.	1	17	4	Imm. III. sat. ♃
6.	0	2	10	Em. II. sat. ♃
9.	1	8	36	Em. I. sat. ♃
10.	37	21	0	☌ ☿ ♀
	19	37	27	Em. I. sat. ♃
11.	4	19	30	☌ ☽ ♅
12.	6	49	24	● New Moon.
	19	7	0	☌ ☽ ♀
	22	29	0	☌ ☽ ☿
13.	18	39	30	☌ ☽ ♂
17.	21	33	2	Em. I. sat. ♃
20.	1	58	12	☽ First Quarter.
	18	24	2	☉ enters ♒
22.	0	26	0	☌ ☽ ♃
	2	38	3	☌ ☽ η ♉ •
23.	18	34	25	Em. II. sat. ♃
24.	23	28	40	Em. I. sat. ♃
26.	17	10	53	○ Full Moon.
	17	57	37	Em. I. sat. ♃
30.	21	11	2	Em. II. sat. ♃

February.

D	H	′	″	
1.	1	24	22	Em. I. sat. ♃
2.	17	21	58	Im. III. sat. ♃
	19	53	21	Em. I. sat. ♃
	22	35	47	☾ Last Quarter.
4.				☿ greatest elong.
	22	30	30	☌ ☽ α ♏ •
5.	11	45	0	☌ ♀ ♂
6.	23	47	35	Em. II. sat. ♃
9.	21	22	44	Em. III. sat. ♃
	21	48	10	Em. I. sat. ♃
11.	3	6	25	● New Moon.
12.	3	17	45	☌ ☽ ♀
	5	30	0	☌ ☽ ☿ •
13.	23	48	49	Im. I. sat. ♃
16.	23	44	41	Em. I. sat. ♃
18.	7	58	50	☌ ☽ η ♉ •
	12	4	5	☽ First Quarter.
	18	13	55	Em. I. sat. ♃
19.	7	22	0	☿ infer. ☌
	9	35	4	☉ enters ♓
24.	18	18	20	Em. II. sat. ♃
25.	5	6	21	○ Full Moon.
	20	9	45	Em. II. sat. ♃

March.

D	H	′	″	
3.	18	19	9	Em. II. sat. ♃
4.	6	26	17	☌ ☽ α ♏ •
	18	47	15	☽ Last Quarter.
	22	5	37	Em. I. sat. ♃
7.	2	27	29	☌ ☽ ♅
10.	13	15	40	☌ ☽ ☿
	20	55	1	Im. II. sat. ♃
12.	18	30	41	● New Moon.
13.	0	4	[illegible]	☌ ☽ ♂
16.				☿ greatest elong.
17.	19	55	10	Em. III. sat. ♃
19.	18	13	35	☽ First Quarter.
20.	20	26	17	Em. I. sat. ♃
21.	9	44	0	☉ enters ♈
24.	21	29	25	Im. III. sat. ♃
26.	17	34	43	○ Full Moon.
27.	22	22	3	Em. I. sat. ♃

Art. XXVIII.—*Proceedings of the Royal Society of Edinburgh.*

Nov. 18. 1822.—THE Royal Society resumed its sittings for the ensuing session.

A paper by Mr J. F. W. Herschel, was read, "*On the Absorption of Light by Coloured Media, and on the Colours of the Prismatic Spectrum exhibited by certain Flames; with an account of a ready mode of determining the absolute Dispersive Power of any medium, by direct Experiment.*"

At the same meeting was read, "*Observations on the Mineralogy of the Faroe Islands.*" By W. C. Trevelyan, Esq. F. R. S. E.

Nov. 25.—At a general meeting of the Society, the following gentlemen were elected Office-bearers and Counsellors for the ensuing session:—

Sir Walter Scott, Baronet, President.

Right Honourable Lord Gray, } Vice-Presidents.
Hon. Lord Glenlee, }

Dr Brewster, General Secretary.

Thomas Allan, Esq. Treasurer.

James Skene, Esq. Curator of the Museum.

PHYSICAL CLASS.

Sir G. S. Mackenzie, Bart. President. Alexander Irving, Esq. Secretary.

Counsellors from the Physical Class.

Henry Jardine, Esq.	Dr Kennedy.
Professor Wallace.	Rev. Dr Macknight.
Sir James Hall.	Mr Stevenson.

LITERARY CLASS.

Henry Mackenzie, Esq. President. Sir William Hamilton, Bart. Secretary.

Counsellors from the Literary Class.

Right Hon. Lord Chief-Baron.	George Forbes, Esq.
Reverend Dr David Ritchie.	Lord Meadowbank.
Thomas Thomson, Esq.	Professor Wilson.

Dec. 2.—A paper by Dr Brewster was read, "*On the Structure and Functions of the Human Eye, particularly the Crystalline lens.*" The object of this paper was, to give an account of the author's experiments on the human crystalline, separate from those in which he has for many years been engaged on the Crystalline Lenses of Animals, and an abstract of which was laid

before the Society, on the 17th of May 1819. The paper was divided into three heads:

1. On the Structure of the Human Crystalline Lens.
2. On the changes produced upon the Human Crystalline by age.
3. On some remarkable affections of the Retina.

On the same evening, a paper by EDWARD GRIMES, Esq. R. N. was read, entitled, "*Observations on the Flints of Warwickshire.*" Mr Thomas Allan presented to the Museum of the Society, the specimens which illustrated the paper.

At this meeting, the following gentlemen were elected Ordinary Members:

Dr Shortt, Edinburgh.
Dr Wallich, Superintendant of the Botanical Garden, Calcutta.
Robert Abercrombie, Esq. of Birkenbog.

ART. XXIX.—*Proceedings of the Wernerian Natural History Society.*

1822, *Nov.* 16. PROFESSOR JAMESON communicated to the Society Mr Trevelyan's account of the geognosy of the coast of Northumberland near Bamborough. He also read extracts of a letter from Dr Oudney, leader of the African exploratory expedition, dated at Morzouk in June last.

Dr Hibbert then read an account of the natural expedients resorted to by a boy in Cheshire, for supplying the want which he has sustained since birth of his fore-arms and hands.

At the same meeting the Secretary communicated a list of birds observed in the Zetland Islands by Mr Laurence Edmondston, in addition to those recorded by authors. Also a treatise on the Melastomaceæ, including descriptions of eleven new genera, by Mr David Don, curator of the Lambertian Herbarium. And he likewise read two communications from Lord Gray, now in Italy, containing notices of the experiments of the Chevalier Morosi of Milan, on the excitation of heat by friction, and on an effectual mode of soldering broken pieces of cast-iron.

Nov. 30.—The Secretary read a paper by the Reverend George Young of Whitby, on the mode in which the remains of quadrupeds may have been brought together in the celebrated Kirkdale Cavern, Yorkshire, and confuting the hypothesis of its having been a den of hyænas.

Mr Charles Anderson of Leith presented to the meeting an improved measure, for ascertaining small quantities of liquids with expedition and accuracy.

Professor Jameson then communicated extracts of letters, giving a general account of discoveries made by Capt. Scoresby, during the last summer and autumn, on the east coast of West Greenland; he having explored a stretch of about 800 miles of that almost unknown region. He found the coast totally unlike that laid down in our best charts, and differing very widely in its position. He was within 200 miles of the presumed site of the lost colony. He every where remarked traces of inhabitants, without seeing any. He found on some parts of the coast a line of open sea, about 20 miles broad, but in others the main ice was very near the shore.—The Professor then read an account of a new species of Lophius (L. Histrio), from the West Indies, by the Reverend Mr Guilding of St Vincent's; and he also communicated a notice of a mammoth's tusk, 6½ feet long, dug up at Rugby in Warwickshire, the tusk being at the same time exhibited.

At this meeting the following gentlemen were elected office-bearers of the Society for the ensuing year:

ROBERT JAMESON, Esq. President.

Robert Stevenson, Esq.
David Falconar, Esq.
Dr David Ritchie,
Rev. Principal Baird,
} Vice-Presidents.

Pat. Neill, Esq. Secretary.	Wm. Ellis, Esq. Treasurer.
James Wilson, Esq. Librarian.	P. Syme, Esq. Painter.

COUNCIL.

Dr Samuel Hibbert.	R. K. Greville, Esq.
P. Small Keir, Esq.	Sir William Jardine, Bart.
Robert Bald, Esq.	Rev. James Grierson, M. D.
Professor Dunbar.	Professor Graham.

At this meeting, also, the following gentlemen were elected members.

ORDINARY.

The Rev. Dr D. Scott of Corstorphine. G. A. Walker Arnott, Esq. A. M.

NON-RESIDENT.

Hercules Scott, Esq. Prof. Moral Phil. in the Univ. and King's College, Aberdeen.
The Rev. Lansdown Guilding, B. A. F. L. S. &c. of the Island of St Vincent's.
Captain William Edward Parry, R. N.
Captain William Franklin, R N.
John Richardson, M. D. Naturalist to the American Land Expedition.
Alexander Fisher. Esq. R N. Surgeon, at present with Captain Parry.

CORRESPONDING.

The Rev. George Young, A. M. of Whitby.
Laurence Edmondston, Esq. of Zetland.
David Don, Esq. Librarian to the Linnean Society.
William Jack *jun.* Esq. Naturalist with Sir Stamford Raffles, Sumatra.
J. S. Miller, Esq. A. L. S. Author of the Natural History of the Crinoidea.

FOREIGN.

Robert Lyal, M. D. of Moscow.

ART. XXX.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Second Comet of* 1822.—This comet was discovered by M. Pons, at Marlia, on the 13th July 1822. It was seen by M. Gambard at Marseilles on the 20th July, and in Germany not till the 20th of August. The following are the parabolic elements, derived by M. Harding from observations on the 21st and 27th of August, and the 2d of September, and also those of M. Encke at Seeberg.

	HARDING. Parabolic Orbit.	ENCKE. Elliptical Orbit.
Time of Perihelion, 1822, Oct. 23.	2h 45′ 1″	Oct. 24. 99374 M. Time.
Long. of Perihelion,	272° 28′ 31″	270° 31′ 30″ .7
Long. of Node,	92 24 50	93 4 52 .4
Inclination of Orbit,	52 28 46	52 39 41 .8
Log. of shortest distance,	0.062358	0.0545019
Excentricity,		0.96617805
Log. of half the greater axis,		1.5253033

2. *Longitude of New York.*—From the solar eclipse of August 27. 1821, Professor Renwick has deduced the longitude of New York, which he finds to be 74° 5′ 11″, or 4h 56′ 23.4″ W. from Greenwich. The observations were made from the cupola of Columbia College, the latitude of which is 40° 42′ 45″.

OPTICS.

3. *Bauman's Dynameter for measuring Magnifying Powers.*—This simple instrument consists of a small tube, having within it a mother-of-pearl scale, divided into tenths of a

line, the divisions being read off with a small eye-glass at the other end of the tube. When distinct vision is obtained in the telescope, the small tube is held against the eye-glass of the telescope, and the observer sees how many divisions of the scale are occupied by the small luminous circle in the centre of the eye-glass. The clear diameter of the object-glass is then divided by this quantity, and the quotient is the magnifying power. This apparatus was first described in the *Ephemerides de Berlin* for 1775. Mr Ramsden had, fifteen years before, constructed a similar instrument, in which he measured the diameter of the small luminous circle, by the extent of the two images formed by two semilenses.—See the *Bibl. Universelle*, Sept. 1822, p. 6. Note.

MAGNETISM.

4. *Magnetism of the Violet Rays.*—The Royal Academy of Sciences of Lyons, have offered a prize of 300 francs, for a solution of the interesting question respecting Morichini's experiments on the magnetising influence of the violet rays. (See this *Journal*, vol. i. p. 239.) The competitors are required "to shew, by decisive experiments, if the violet ray of the solar spectrum possesses the virtue of communicating magnetism to the unmagnetised needle of steel;—if this virtue belongs to it, to the exclusion of the other coloured rays;—and, in short, if this species of communicated magnetism, attributed to the violet light, is real or illusory." In the programme of this prize, it is stated, that Professor Configliachi of Pavia, found that the same kind of magnetism was communicated by every other ray of the simple light of day, and even in total darkness. The memoirs to be sent to MM. Mollet and Dumas, Secretaries, before the 30th of June 1823.

5. *Steinhauser's Method of making Artificial Magnets.*—Professor Steinhauser has found, that the usual operation of double touch should be performed in a circle; and that, in magnetising horse-shoe magnets, two of them should be placed with their friendly poles together, and the touch performed circularly. Upon the separation of the two horse-shoe magnets, a considerable part of their force is lost, unless the great circuit is previously formed into two smaller ones, by joining the poles of

each with a piece of soft iron. By these rules, magnets of extraordinary power may be made.

ACOUSTICS.

6. *Velocity of Sound.*—The velocity of sound in the atmosphere has been recently measured with great care by a committee of the Members of the Institute of France, consisting of MM. Prony, Bouvard, Mathieu, and Arago. The result of their observations was, that at the temperature of $+10°$ of the centigrade thermometer, the velocity of sound in a second is 173.01 toises, or 337.2 metres, $=1106$ English feet, and 4 inches at the temperature of 50° of Fahrenheit. The academicians, in the year 1738, had obtained 173.84 toises at the same temperature.—*Biblioth. Universelle*, Sept. 1822, p. 27.

7. *On Sounds excited in Hydrogen Gas.*—When we inserted in No. XIII. a notice * of Mr Leslie's experiments on the sounds excited in hydrogen gas, we were not aware that similar experiments had been made, so early as 1812, by Messrs Kerby and Merrick, till it was pointed out to us by an esteemed correspondent. "I have not," he remarks, "the Transactions of the Philosophical Society of Cambridge, and I cannot therefore tell what Mr Leslie's experiments may be; but if they only go to shew that hydrogen is a bad conductor of sound (and this is what I collect from your account in the Philosophical Journal), the fact has been established long ago. You will find it in Nicholson's *Journal*, vol. 33. p. 168, among other experiments of the same kind on different gases, made by Messrs Kerby and Merrick in 1812 †." These very curious experiments, with additional calculations, have been republished by Mr Farey *sen.* in the article GASES in the EDINBURGH ENCYCLOPÆDIA, vol. x. p. 121. Our correspondent will observe, that we have given in No. XIII. all the facts in Mr Leslie's paper, which occupies only a few lines more than a page in the Cambridge Memoirs.

* The word *Rarefaction* in that notice was twice misprinted, from the types being transposed, and falling out.

† M. Chladni of Wirtemberg had determined very long ago, that both hydrogen and azote give a note considerably lower than what we should infer from calculation.

METEOROLOGY.

8. *Mr Anderson's New Atmometer.*—Mr Anderson of Perth has invented a new atmometer, for measuring the spontaneous evaporation from the surface of water, in any given time. This instrument is quite different from the atmometer described by Mr Anderson in the 2d volume of this Journal, and is free from all the objections to which these instruments, as they have been hitherto constructed, are liable. We hope to be able to give an account of this invention in an early number.

9. *Singular Storm at Enghien*—In a very interesting work, entitled *Journal of a Horticultural Tour*, performed by a Deputation of the Horticultural Society of Scotland, and just published, we find the following account of a singular storm, which took place at Enghien, on the 12th September 1817. "A dense black cloud was seen advancing from the east, and as this cloud developed itself and increased in magnitude, one half of the horizon became shrouded in darkness, enlivened only by occasional flashes of forked lightning, while the other half of the horizon remained clear, with the sun shining bright. As the black cloud approached, the sun's rays tinged it of a dull copper colour, and the reflected light caused all the streets and houses to assume the same lurid and metallic hue *. A sort of whirlwind which even raised the small gravel from the streets, and dashed it against the windows, preceded the rain, which fell in heavy drops, but lasted only a short time. The sun now became obscured, and day converted into night." The Deputation were at the house of M. Parmentier during the storm, and so great was the darkness, that they were obliged to use candle light in examining some valuable continental publications connected with botany and horticulture, which were shewn to them by M. Parmentier.—*Horticultural Tour*, p. 329, 330.

10. *Enormous Fall of Rain in the Tropics.*—The following singular and almost incredible statement, is given in Professor Silliman's American Journal of Science, vol. iv. p. 375, on the authority of a letter from M. Roussin, captain of a vessel, dated Cayenne, 28th February 1820. "You will perhaps learn

* Mr Neill informs us, that this effect was so remarkable, that every thing had the same appearance as if it had been made of copper.—Ed.

with no inconsiderable interest, the following meteorological fact, the authenticity of which I am able to certify. From the 1st to the 24th of February, there fell upon the Isle of Cayenne *twelve feet seven inches* of water. This observation was made by a person of the highest veracity; and I assured myself, by exposing a vessel in the middle of my yard, that there fell in the city *ten and a quarter inches* of water between eight in the evening and six in the morning of the 14th and 15th of that month. From these enormous rains has resulted an inundation from which every plantation has suffered.

11. *Great Dryness of the Air at Perth.*—The dryness of the air at Perth on the 13th of June, was greater, according to the hygrometric formula of Mr Anderson, than it has been observed on any former occasion, with suitable instruments. While a naked thermometer stood in the shade at 78°, one covered with moistened cambric was so low as 60°. The difference, amounting to 18°, indicated that the air was so partially charged with humidity, that it could have retained in the state of vapour more than double the quantity of water, which it actually held in solution. The evaporation, estimated by means of two instruments of great delicacy lately invented by Mr Anderson, was at the rate of $\frac{1}{50}$th of an inch per hour from 3 to 6 o'clock P. M. If the evaporation were to proceed at this extraordinary rate during the whole month, it would amount, in thirty days, to about 14 inches of perpendicular depth. The low temperature of the night, however, which (for reasons Mr Anderson explained in a paper read before the Literary and Antiquarian Society) always attends a dry state of the atmosphere, must reduce it greatly below the calculations; insomuch, that it would probably be rated too high even at a third part of what has been stated, actual evaporation for the past part of the present month being only $2\frac{1}{10}$th inches.

HYDRODYNAMICS.

12. *New Steam-Engine of great Power.*—We understand that Mr Perkins has invented a new steam-engine, founded on a new property in steam, by which more than *seven-eighths* of the fuel and weight of engine may be saved. He has constructed a small one, with a cylinder *two* inches in diameter, and a stroke of *twelve* inches, which has the power of *seven* horses.

II. CHEMISTRY.

13. *Dr Wollaston's Test for Magnesia.*—If a solution containing magnesia, decomposed by a mixture of phosphate and carbonate of ammonia, is spread upon a plate of glass, and if we trace any word, *Magnesia* for example, upon the glass thus covered, with the extremity of a glass rod, the word will appear in *white* characters. The magnesia re-dissolved by the excess of the carbonate, is precipitated upon the traces of the glass rod, in consequence of the expulsion of the carbonic acid by the heat disengaged by friction. When there is no precipitation on the traced characters, then no magnesia has been present in the solution.

14. *Method of making Green Fire.*—When the following composition, which has been a desideratum in pyrotechny, is burned in a reflector, it sheds a beautiful green light over surrounding objects. It may likewise be employed in fire-works.

Flowers of Sulphur, . .	13 parts.
Nitrate of Barytes, . .	77
Oxymuriate of potash, . .	5
Metallic Arsenic, . .	2
Charcoal, . . .	3

The nitrate of barytes should be well dried and powdered, and then mixed with the other ingredients, all finely pulverised and triturated till they are perfectly mixed together. In order to make the combustion slower, a little calamine may be added. —*Journal of Science*, vol. xiv. p. 232.

15 *Fusion of Charcoal by Hare's Deflagrator.*—Mr Hare had some time ago observed, that the charcoal points, when ignited by the instrument, "assumed a pasty consistence, and appeared as if in a state of fusion." This most important fact seems to have been placed beyond a doubt by Professor Silliman, who has obtained some very curious and valuable results with the Deflagrator.

When the charcoal points were brought into contact, and then withdrawn a little, the most intense ignition took place. The charcoal part of the *positive* pole shot out and increased

from the 10th to the 8th, and sometimes to the 4th of an inch in length. The charcoal of the negative pole, on the contrary, was diminished, and a circle-shaped cavity was formed at the end of it, as if the matter had been actually transferred to the positive pole, by a current flowing from the negative to the positive pole. From various experiments, Professor Silliman concludes, "*that there is a current from the negative to the positive pole, and that carbon is actually transferred by it in that direction,*" probably in the state of vapour.

Upon examining with a microscope the projecting point of the positive pole, it exhibited decisive indications of having undergone a real fusion. It presented a mamillated appearance, and its form was that of an aggregation of small spheres. Its surface was smooth and glossy, as if covered with a varnish. Its lustre was metallic, and it had entirely lost the fibrous appearance. It resembled brown hæmatite. The pores of the charcoal had all disappeared, and the matter had become sensibly harder and heavier.—Silliman's *Journal*, vol. v. p. 108,—112.

16. *Crystallisation under Pressure.*—By means of a powerful machine, by which a pressure of 1400 atmospheres may be obtained, Mr Perkins has, we learn, made several very important discoveries respecting the crystallisation of sea-water and other solutions under this pressure. His discoveries have been communicated to the Royal Society of London.

17. *Ammonia in Lava.*—Professor Gmelin of Tubingen is said to have discovered in clinkstone lava ammonia, which is disengaged by distillation. He also found it in columnar basalt.

18. *Test for Barytes and Strontian.*—In order to distinguish these earths, make a solution of either, by nitric, muriatic, or some other acid, which will form a soluble salt with it. Add solution of sulphate of soda in excess, filter and then test the clear fluid by subcarbonate of potash. If any precipitate falls down, the earth is strontian, but if the fluid remain clear, it is barytes.

19. *Analysis of Tabular Spar from Lake Champlain.*—The following is the analysis of this mineral by M. H. Seybert of Philadelphia. Specific gravity 2.884.

Silica,	51.00
Lime,	46.00
Alumina and Oxide of Iron,	1.33
Water,	1.00
Magnesia, a trace.	
	99.33

It is therefore a bisilicate of lime, and its mineralogical formula is $C\,a\,S^2$.—*Amer. Journ.* vol. v. p. 114.

III. NATURAL HISTORY.

MINERALOGY.

20. *Analysis of Green Pyroxene.*—This mineral accompanies the preceding, and was analysed by the same chemist. Specific gravity 3.377.

Silica,	50.33
Protoxide of Iron,	20.40
Lime,	19.33
Magnesia,	6.83
Alumina,	1.53
Water,	0.67
Protoxide of Manganese a trace,	
	99.0

Id. p. 116.

21. *Analysis of Colophonite.*—This mineral accompanies the preceding, and was analysed by the same chemist. Specific gravity 3.896.

Silica,	38.00
Lime,	29.00
Protoxide of Iron,	25.20
Alumina,	6.00
Water,	0.33
	98.53

Id. p. 118.

22. *Honourable Mr Knox on the Newry Pitchstone.*—The pitchstone of Newry in Ireland, described by the Honourable G. Knox, in the volume of the Transactions of the Royal Society just published, occurs in veins in granite, and, in mineralogical relations, agrees with the pitchstones of the Island of Arran, in the Firth of Clyde. Mr Knox states the fol-

lowing as the most distinctive characters of the Newry pitchstone; its ready divisibility into laminæ; its proneness to disintegrate; the regularity of its rhomboidal fragments, and its *oily or bituminous smell.* The bituminous smell led Mr Knox to believe, that the pitchstone contained some inflammable matter; and after a series of experiments, detailed in his memoir, he found, that the pitchstone of Arran, Newry and Meissen in Saxony, afforded two inflammable substances; the one more volatile than the other, but both inseparable from the stone, except at a heat approaching, if not entirely amounting to, whiteness. He conjectures it to be a combination of naphtha and nicotine. The following is the result of his analysis of the Newry pitchstone: Silica 78.800, Alumina 11.500, Lime 1.12, Protoxide of Iron 3.036, Soda 2.857, Water and Bitumen 8.500, = 99.813. Professor Jameson, in his Mineralogy of the Scottish Isles, vol. i. p. 48., says, when describing the Arran pitchstone, " when pounded, *it emits a bituminous smell, which renders it probable it may contain an inflammable matter.*" The pitchstones mentioned by Kirwan as containing inflammable matter, appear to be not true pitchstone, but opals. The pitchstone of Planitz in Saxony, like that of Arran, we know contains bituminous matter; and we have specimens from that quarter, containing a black silky fibrous shining substance, which is a compound of silica, carbon, alumina and iron. And we may add, that, according to some chemists, the pitchstone of Potschappel in Saxony, contains, besides the usual ingredients, three parts of *Lithion.* Mr Knox formed a substance resembling pumice, by exposing the pitchstone to the action of heat; but for the details on this curious subject, we must refer to the memoir itself.

23. *Changes in Carrara Marble.*—According to Em Ripetti (Giorn. Arcad. xlv. 54.) the marble of Carrara affords an example of the chemical change of a mountain rock without its disintegrating. The marble rocks of Carrara have not every where the pure snow-white colour for which they are so famous, but are for the most part greyish-white, and are only snow-white in certain parts, where veins and spots of oxide of iron, sulphate of iron, and iron-pyrites, have been formed. Some of these spots seem to be of old formation, and fixed; others, on the contrary, appear to be forming at present, and are again

carried away by the percolating water, and leave the marble, for the first time, of a pure snow-white colour *. Whole rocks appear to be changed in this way by a chemical process. In illustration of this, it is remarked, that the rock of the old quarry named Di Poggio Silvestro, was formerly useless, but during the lapse of time has become pure white marble: and further, that the different kinds of Carrara marble change in the course of time, and generally become purer.

24. *On the Formation of Rock-Crystal.*—Spallanzani remarks, that the numerous beautiful rock-crystals in the cavities of the Carrara marble, continue still to form, and from a pure acid fluid. Ripetti, in his tract "Sopra l'Alpe Apuana ei Marmi di Carrara, 1811," adduces some new observations in favour of this opinion, and tells us, that, on opening a drusy cavity, there was found 1½ lb. of the above fluid, and among the solid crystals, a soft mass the size of the fist, which, on exposure to the air, hardened into a substance having the characters of calcedony. According to Daubuisson and Beudant, the opal of Hungary is sometimes found in a soft state.

25. *New Analysis of Heliotrope*—According to Brandes and Firnhaber it contains, Silica, 96.25; Oxide of Iron, 1.25; Alumina, 0.83; Water, 1.05, = 99.58.

26. *Colouring of Marble.*—The ancients were acquainted with a mode of communicating various lively and very durable colours to marble, hitherto unknown to us. Lately Ripetti, in his tract published at Florence in 1821, entitled "Sopra l'Alpe Apuana ei Marmi di Carrara," throws some light on this subject. Among the different sorts of marble of Carrara, that of the quarry Di Betogli is particularly fine granular, and pure snow-white, but at the same time uncommonly changeable. When exposed to the air for some months, it loses a portion of its water and its carbonic acid, becomes brittle, and specifically lighter, and in two years suffered a loss of 7 per cent. The workmen, on account of its property of easily falling in pieces, name it *burnt marble* (M. concotto or Salone). This evil is cured in part by rubbing it with Euphorbia characias, L.; but it is principally employed to colour the marble, which absorbs the

* The workmen say, Il marmo si purga.

colouring matter readily. Figures, fruits, &c. cut of this marble, and penetrated with colours by means of heat, have a very agreeable appearance, and in durability of colour resemble the variegated marble paintings found in the Temple of Nemesis at Ramno, and in other places.

27. *Chemical Analysis of Tabular Spar by Rose.*—He gives the following as the constituent parts of the tabular spar of Perheniemi in Finland.

51.60	Silica, containing		25.93 Oxygen.
46.41	Lime, containing	-	13.03 Oxygen.
	A trace of Oxide of Iron.		
1.11	Intermixed particles of actynolite.		
99.12			

This tabular spar is therefore a bisilicate of lime, and has the same chemical constitution as augite.

Rose remarks, "The forms of augite and tabular spar are different; the angles of the prism of augite is 92° 18′, and 87° 42′.; but on tabular spar, on the contrary, according to the measurement of his brother, they are 95° 18′, and 84° 42′." This fact, he further remarks, is striking, although it is not solitary. Calc-spar and arragonite have the same composition, but differ in form; also garnet and vesuvian, and iron-pyrites and spar-pyrites. M. Mitscherlich has found that an artificial salt, the acid phosphate of soda, can crystallise in two different forms. This appearance seems to depend on a different arrangement of the individual constituent parts, by which not only different forms, but also different chemical properties may take place. The augite, for instance, is not attacked by acids, while they decompose the tabular spar with ease. This appears to be connected with the different relations to acids, which Berzelius has observed in many bodies which have been exposed to heat, or are in their unaltered state; for example, in the gadolinite, zircon earth, the oxide of chrome, and many antimonial salts.

28. *On the Calaite, or Turquois of Persia, and the Lazulite.*—Berzelius finds that Calaite is a compound of phosphate of alumina, phosphate of lime, silica, oxide of iron, and oxide of copper. The *Lazulite* is a compound of phosphate of alumina, phosphate of manganese, and of phosphate of iron and oxide of iron.

29. *Transactions of the Geological Society.*—The Geological Society has just published a half volume of Transactions, being the commencement of a new series. It contains the following papers:—On the Geology of the southern coast of England, from Bridport to Babbacombe Bay, Devon, by *H. T. De la Beche, Esq.*—On the Bagshot Sand, by *Henry Warburton, Esq.* —On a Fresh-water Formation in Hordwell Cliff, by *Mr Webster.*—On Glen Tilt, by *Dr MacCulloch.*—On the Excavation of Valleys by Diluvian action, by the *Rev. Professor Buckland.* —On the genera Ichthyosaurus and Plesiosaurus, by the *Rev. W. Conybeare.*—Outline of the Geology of Russia, by the *Hon. William T. H. Fox Strangways.*—On the Geology of the coast of France, Department de la Seine Inferieure, by *H. T. De la Beche, Esq.*—On the Valley of the Sutluj, in the Himalaya Mountains, by *H. T. Colebrooke, Esq.*—On the Geology of the north-eastern border of Bengal, by *H. T. Colebrooke, Esq.*; with various other papers and notices; the whole illustrated by 24 plates, maps and sections, many of them coloured.

BOTANY.

The following notices, on subjects connected with Gardening and Botany, are derived from a work just published, under the title of "Journal of a Horticultural Tour by a Deputation of the Caledonian Horticultural Society," and which, we believe, was written chiefly by P. Neill, Esq. Secretary of that Society, and no doubt owes much of its value and interest to his learning, sagacity, and activity of research.

30. *Succory as a Blanched Salad.*—The *Cichorium Intybus* or succory, is a plant indigenous to Britain, rare indeed in Scotland, but very common in the chalk districts of England. A variety of this plant, improved by cultivation, is found very useful in France, and it seems strange that it should be wholly overlooked in this country. The young leaves are used in salads, and for this purpose successive sowings are made in gardens. When the plant is raised in fields, the outer leaves are plucked at different periods of the summer and autumn, and given to milch cows. Cows fed on them are said to yield generally about a third more milk than when on ordinary fodder;

but at first the milk acquires somewhat of a bitterish taste. This kind of green food is also accounted excellent for promoting the production of butter. At the approach of winter, the roots of the succory plants are dug up and stored in a cellar or out-house. They are laid horizontally in a bed composed of sand or light soil, with the crowns or heads outermost and uncovered; a thin layer of soil is then added; then another row of roots; and this is repeated till the beds be perhaps three or four feet high. It is only necessary that the place in which the roots are thus stored be defended from frost; light is not only unnecessary, but would be prejudicial. Here they afford the blanched shoots called *Barbe-de-Capucin*, much relished in France as a winter salad. Frequently the roots are packed among moist sand in a barrel, having numerous round holes pierced in its sides: the crowns of the succory plants are so placed, that the shoots may readily push their way through the holes: they are thus kept quite clean, are very easily gathered as wanted, and repeated cuttings are obtained. Barrels thus prepared are sometimes carried on board vessels about to sail on long voyages, and fresh salads are thus procured after the ship has been some months at sea. When sent to the Paris market, the succory roots are generally drawn from the beds, and tied in bunches, with the etiolated shoots attached to them.—*Hort. Tour*, p. 368.

31. *Ringing of Walnut-trees.*—The Baron de Tschoudi, near Metz, in Lorraine, has introduced the practice of ringing his walnut-trees; taking out two inches of the outer bark all all around, and plastering over the part with the "onguent de St Fiacre," *i. e.* clay mixed with cow-house cleanings. The ringed walnut-trees not only prove more prolific, but the fruit is more early.—*Hort. Tour*, p. 489.

32. *Ailanthus glandulosa.*—This Japan tree has become a common ornament of gardens at Paris, while in England it is rather neglected. It seems admirably well adapted for planting on the margins of public promenades, as it flourishes in the poorest and most arid soil, sending its spreading roots abroad in search of moisture and nourishment. In the hard gravel-walks of the Jardin des Plantes, it remained quite green, after the parching heat and drought of July and August; while the lime-trees (rows of which extend the whole length of the gar-

dens, on each side of the central walk) had been much burnt up, or nearly deprived of their foliage. The ailanthus likewise continues long in verdure: towards the end of September, it still retained its fine pinnated leaves, long after the walnut and the ash had shed theirs.

33. *Peat Mosses of Holland.*—Without coals, and without copse-wood, the Dutch have to depend on their *veener* or peat-mosses for fuel. There are two kinds of these, the higher and the lower. The high mosses afford a layer of what is called grey or dry peat. This upper bed of peat is generally about six feet in thickness: it seems to be composed rather of leaves and stems of reedy plants, than of heath, or the plants which commonly accompany heath; and fragments of large branches of trees have sometimes been found in it. Beneath this peat, a thin bed of blue clay commonly appears, and which, on the peat being removed, forms arable land. The low mosses afford what are called mud-peats, and when these are taken from the inferior layer of such moss, the excavation speedily becomes covered with water. When the under stratum of moss is firm and contains wood, it is called *derry*. Many trunks of trees occur in it; and these uniformly lie with their heads pointing eastward, showing that the storm or debacle which overwhelmed them had come from the west. Some of the timber, oak in particular, remains sound, so that it can be used in carpentry; but it is of a dark colour, as if stained with ink. There is a law against digging through this derry in the lowest parts of the country, much water being found to ooze in the sand below, and to be repressed by the compact layer of wood-moss.—*Hort. Tour*, pp. 187. and 237.

34. *Dutch Ashes* are in great request by the industrious farmers around Ghent, and in other parts of Flanders, proving to them a very useful manure. So far as we could learn, they are little used in Holland itself; but they are carefully collected and sent by water to the Flemish agriculturists. As might be expected, Amsterdam produces by far the largest quantity. Messrs Sielring and Vander Aa, of that city, are the principal dealers. They have a lease of all the ashes of the capital, and likewise of those of the neighbouring towns. In Amsterdam

they have 80 carts and horses, and as many men, daily employed in carting the ashes. These are carefully separated from the street manure, and stored under long shades on one of the quays, where they lie ready for exportation. For information regarding the employment and utility of these ashes in agriculture, reference may be made to the publications of Sir John Sinclair and Mr Radcliffe. They are also found useful in horticulture. M. de Wulf of Ghent, particularly recommends their use both in the garden and orchard. He observes, however, that they should not be laid on the borders very recently after being taken from the fire, for in that case they would prove injurious; but that after being kept for a short time, and if they be applied in a small quantity, they never fail to produce the best effects. M. de Wulf particularly mentions, that fruit-trees in a languishing state in his garden, have been restored to vigour, by the application of ashes. He considers that they not only tend to open the soil, and to stimulate it, but also assist in affording additional nourishment to the plants, by means of the water which they absorb and gradually give out; and that by carrying into the soil principles calculated to attract the carbonic acid of the atmosphere, the solubility of the portions adapted for the food of plants is promoted. If no rain or dew fall soon after the application, slight waterings from the rose of a watering-pot are proper. When ashes are old, or have been long kept, they may be spread in the garden in greater quantity: they then not only help to keep the surface of the soil damp, (an object of great importance in a light sandy soil, and under a parching sun), but attract and preserve much carbonic acid. When old garden soils are overloaded with rich mould, or where too frequent manurings have been given for a series of years, stale ashes are found the best restorative of the soil to a due state of sharpness and activity.—*Hort. Tour*, p. 238.

ZOOLOGY.

35. *On the White and Black Ants of India* *.—The following observations on the habits of two species of Indian ants, were communicated to me by a relative, who resided some time in India. They are more worthy of attention, because they

* This interesting notice was communicated by Dr Traill of Liverpool.

tend to confirm some of the most interesting facts mentioned by Smeathman and others, whose narratives have been suspected of exaggeration; and were made by a lady, who was wholly unacquainted with the writings of these authors:

"The White Ant * of India is particularly fond of burrowing in the mud walls of the Indian houses. My attention was one morning attracted by the appearance of a wet spot on the coloured wall of my apartment, at a season, and in a situation, to preclude the supposition of this having been occasioned by rain, or by accident. This led me to examine the spot, and, on slightly touching it, the plaster gave way, and I discovered that a part of the wall behind was hollow. From this I concluded that there was a nest of ants lodged in it; and, on looking narrowly, I heard a sound produced by a rapid succession of strokes, a mimic *alarm-beat*, and immediately a great number of white ants came to the place, with their mouths filled with wet mud, with which they repaired the breach in a few minutes. Their whole proceedings were so curious and interesting, that I frequently amused myself with pulling down what they repaired, and observed that there was always an alarm beat before they came to build it up.

"I have been highly amused with the conduct of the Black Ants †, animals much more daring, though less destructive, than the white ones. I have often observed, that when one or two of them found a large dead insect, or any such substance, too big for them to carry off, that they would go away, and soon return with a number of their species sufficient for the purpose. A gentleman several times sprinkled one or two black ants, engaged in examining a dead insect, with hair-powder. They retreated, and soon after he saw his powdered acquaintances at the head of a large column of ants, marching to secure the prize, which had been discovered by their scouts. I have also observed the black ants removing from one place to another in a large body, marching in a very regular column, excepting a few, who seemed to act as overseers. These last marched on each side of the large body, and occasionally turned back, when

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* The White Ant of India is *Termes bellicosus*, Linn.

† The Black Ant of India appears, from description, to be the *Formica elongata*, Linn.

any thing deranged the line of march; and they never failed to hasten the advance of the loiterers."

36. *On the limits of the occurrence of Fishes in high situations.*—According to Raymond, the only fishes that occur in the waters of the Pyrenees, at heights of from 1000 to 1162 toises, are Salmo Trutta, S. Fario, and S. alpinus. Higher up, all fishes disappear. The water-salamander also ceases to live at a height of 1292 toises;—probably because the numerous higher lakes are generally half the year covered with ice. But the following fact mentioned by Humboldt, proves that cold is not the sole cause of the disappearance of fishes in high places, viz. that in the equatorial regions of America, where the mean temperature of 0° of the Centigrade scale, or the freezing point of water, begins 1500 toises higher than in the Pyrenees, the fishes disappear earlier in the lakes and rivers. No Trouts occur in the Andes. At a height of from 1400 to 1500 toises, there still occur Pocilien, Pimelodes, and the very remarkable new form Eremophilus and Astroblepus. Under the Equator, from 1800 to 1900 toises, where the mean temperature is still + 9° 5′ Cent., and where most of the lakes scarcely freeze any time during the year, fishes are no longer met with, with the exception of the remarkable Pimelodes Cyclopum, which are thrown out in thousands with the clay-mud, projected from fissures of the rocks, at the height of 2500 toises. But these fishes live in the subterranean lakes.

37. *Fossil Elk of the Isle of Man.*—The following are some of the dimensions of the splendid specimen of this fossil animal, in the Royal Museum of the College of Edinburgh.

	Ft.	In.
Height to the tip of the process of the first dorsal vertebra, which is the highest point of the trunk,	6	1
Height to the anterior superior angle of the scapula,	5	4
Length from the first dorsal vertebra to the tip of the os coccygis,	5	2
Height to the tip of the right horn,	9	7½
Lateral or horizontal diameter of the thorax, at the widest part, that is, at the eleventh rib,	2	0½
Depth of the thorax, from the tip of the process of the eighth dorsal vertebra to the sternum at the junction of the eighth rib,	2	2

A fine engraving of this specimen, from a drawing by Lizars, will appear in the next volume of the Supplement to the Encyclopædia Britannica. This species, the most perfect ever known,

was dug up in the parish of Kirk Balaff, and secured for the Royal Museum, by the exertions of his Grace the Duke of Athole. It was imbedded in loose shell-marl, in which were numerous imbedded branches and roots. Over the marl was a bed of sand; above the sand a bed of peat, principally composed of small branches and rotten leaves; and over the peat the common soil of the country.

38. *Natural History of Alcyonia, Spongia, Corallina, Sertularia, Eschara, and Corals, from the French of Lamarck, by* J. S. Miller, A. L. S., Corresponding Member of the Wernerian Natural History Society.—We have great pleasure in announcing the intention of Mr Miller, already so well known to the public, by his excellent History of the Crinoidea, to publish a translation of Lamarck's valuable descriptions and histories of the animals above enumerated. It will prove very useful to the English zoologist, and we have no doubt will increase the number of students of this very curious and interesting department of Natural History. This work is, we understand, patronized by the Geological Society of London, and the Wernerian Natural History Society. This kind of patronage was formerly much prized; and we have no doubt, when, as in the present case, judiciously granted, is an important public testimony to the author, of the utility of his work. The following observations are from Mr Miller's printed Prospectus, abridged.

"Although these Classes have formed the subject of many valuable works, yet the history of their fossil genera, which equal in number, beauty, and interest, the recent, have hitherto received comparatively but little attention; and the few and scanty notices which exist concerning them, are scattered through various unconnected publications; nor has any attempt been made to reduce them under a regular arrangement, an object of equal importance to the geologist and general naturalist. Even with reference to the recent species, their general and external forms have alone, in most instances, attracted the regard of those who have undertaken their description, while but little attention has been paid to the phenomena and laws of their internal structure and organization."

39. *Manners of the Asiatic Rhinoceros.*—The following very interesting account of the manners and habits of the Asiatic rhi-

noceros, clothed in armour, and having the welted hide, has been given by Sir Everard Home, in a paper in the Philosophical Transactions for 1822. He obtained the particulars from the young man who was its keeper for three years at Exeter 'Change, where it died. " It was so savage," says he, " that about a month after it came, it endeavoured to kill the keeper, and nearly succeeded. It ran at him with the greatest impetuosity; but fortunately the horn passed between his thighs, and threw the keeper on its head: the horn came against a wooden partition, into which the animal had forced it to such a depth, as to be unable for a minute to withdraw it, and during this interval the man escaped. Its skin, though apparently so hard, is only covered with small scales, of the thickness of paper, with the appearance of tortoise-shell; at the edges of these, the skin itself is exceedingly sensible, either to the bite of a fly, or the lash of a whip; and the only mode of managing it at all, was by means of a short whip. By this discipline, the keeper got the management of it, and the animal was brought to know him; but frequently, more especially in the middle of the night, fits of frenzy came on, and, while these lasted, nothing could controul its rage, the rhinoceros running with great swiftness round the den, playing all kinds of antics, making hideous noises, knocking every thing to pieces, disturbing the whole neighbourhood, then all at once becoming quiet. While the fit was on, even the keeper durst not make his approach. The animal fell upon its knees, to enable the horn to bear upon any object. It was quick in all its motions, ate ravenously all kinds of vegetables, appearing to have no selection. They fed it on branches of the willow. It possesses little or no memory, dunged in one place, and, if not prevented, ate the dung, or spread it over the sides of the wall. Three years confinement made no alteration on its habits."—See *Phil. Trans.* 1822, p. 43, 44.

IV. GENERAL SCIENCE.

40. *Notice of Captain Scoresby's Discoveries on the East Coast of West Greenland, or Lost Greenland, and of his voyage to that country, now in the press.*—This country, on which colonies were planted in the tenth century, that increased up to

near three hundred villages, or farms, with about sixteen churches, two convents, &c. it is well known, was lost to the rest of the world, by the setting in of the polar ice, about the year 1406. Since this period it has not been considered accessible, all attempts to reach it having failed; and the fate of the colonists has been constantly wrapped in that perfect obscurity, which renders it a subject of the most intense interest. The extensive researches and discoveries of our distinguished countryman Captain Scoresby, however, made upon this coast last summer, show that the barrier of ice is not totally impenetrable; and encourage us to hope, that before long, something respecting these unhappy colonists, that have been long shut out from intercourse with other countries, may be developed. Captain Scoresby entered the main western ice in the 76th parallel of latitude, a single ship, on the 23d of May, and got sight of the coast of Greenland, after penetrating about 150 miles, on the 7th of June. At this time it was impossible to get within ten or fifteen leagues of the shore; but in the course of the summer Captain Scoresby was enabled to land in several different places, in almost all of which traces of inhabitants were discovered. He remained on the coast until the 27th of August, during which interval he obtained an accurate survey of nearly the whole line of coast, from latitude 75° to 69°, consisting of an extent, including the various indentations and flexures, of near 800 geographical miles. By this survey, he found that there was an error in the position of the land in latitude 74°, as laid down in most of our maritime charts, of about 15° or 900 miles of longitude. Captain Scoresby's chart is indeed so totally unlike the coast delineated in our best maps, both as to form and position, that the greater part of the land he visited may be safely considered as a *new country*. Various islands and inlets were discovered; many of the latter being large and without apparent termination at the depth of fifty to eighty miles by estimation, are considered by Captain Scoresby as forming communications with Baffin's Bay, to the support of which opinion several circumstances that he observed were favourable. In one of the sheltered bays that he penetrated, to the depth of twenty or twenty-five miles, the weather was oppressively hot, and the air swarmed with bees, butterflies, and musquitoes. The

whole coast was found to be mountainous, and many parts were highly picturesque. We have seen Captain Scoresby's charts, and find that his surveys are founded on about 500 bearings or angles, besides 200 or 300 more for the deviation and variation of the compass, and that these were taken at fifty different stations, mostly determined astronomically. In addition to this survey, he has taken drawings of the land, determined the depth of the water and currents, the variation of the compass, &c. England has been always pre-eminently distinguished in maritime discovery and adventure, and in no age has her enterprise, both public and private, exceeded the present; Parry, Scoresby, and Franklin, are indeed proud names even for this great country. Parry, we hope, is safe, and destined to return to Europe, one of the greatest discoverers of this active and energetic age. Franklin, with the friends and companions of his dreadful journeys, Richardson and Back, are now preparing their journals for the public; and Captain Scoresby, we understand, is about to put to press the deeply interesting history of his investigations and adventures, on the re-discovered coasts of West Greenland.

41. *Steam-Boats in Italy.*—The American Consul at Trieste has, it appears, established a steam-boat called the *Carolina*, which performs every Monday the voyage between that port and Venice. Another, called the *Eridano*, performs the voyage from Venice to Pavia on the Po, in thirty-seven hours. A merchant vessel, richly laden, was lately saved from shipwreck by the *Carolina* steam-boat, when no other vessel could leave the harbour from the severity of the weather.—Professor Silliman's *American Journal of Science*, vol. iv. p. 377.

42. *Scientific and Literary Travels.*—Professor Nevi has been employed by the Emperor of Russia to make researches in the steppes of Independent Tartary, and to examine the course of the Oxus, and the towns of Balk and Sarmacand. The expedition will extend perhaps as far as the Lake Saisan. Ambassadors have been previously sent to prepare the way in these countries, which are so little known; and there is reason to think, that at least much geographical knowledge will result from the expedition.

That public-spirited nobleman Count Romanzoff, who fitted out, at his own expence, the expedition under Kotzebue for cir-

cumnavigating the globe, has sent out travellers to cross the ice from the eastern coast of Asia to the western coast of America.

Professor Rask of Copenhagen, the author of an Icelandic and Anglo-Saxon Grammar, has been for some time studying Sanscrit at St Petersburg, with the view of proceeding to the Birman empire, to study the Pali language, and the sacred books of the Buddhists. He proposes to inquire into the origin of the languages of the north in the mountains of Caucasus.

M. Sieber, a Bohemian naturalist, who travelled in Egypt and Syria in 1817 and 1818, is about to perform a journey in Abyssinia.

43. *Dr Spix and Dr Martius's Travels in Brazil.*—We are informed that a series of works, descriptive of the travels and observations in natural history, made in Brazil in the years 1817, 1818, 1819 and 1820, by Drs Spix and Martius, who were sent out by the King of Bavaria, are in progress of publication. The journal of the travels will appear in two volumes quarto, with numerous maps, geographical and geognostical; portraits of Indian scenes in different parts of the country, &c. The description and history of the animals, will appear partly in quarto, partly in folio. We observe, the folio numbers will contain figures of 37 new apes. This disagreeable tribe appears to be almost inexhaustible The plants are to be published in imperial quarto.

44. *Methods of detaching Paintings in Fresco.*—M. Stefano Barrezzi of Milan has lately discovered a simple method of detaching paintings in fresco from one wall, and transferring them to another. This is effected by a cloth, which is stuck to the face of the picture. The method has even succeeded in rough and uneven walls. M. Barezzi was some time ago engaged in separating the great picture of Marco d'Oggivne in the Church della Pace.—*Rev. Encyclop.* Mai 1821.

45. *Society of Travellers.*—A Society has been established in Liverpool, of those gentlemen who have visited distant countries, either with the view of natural history, or general science. We have long had in view the establishment of such a society in Edinburgh, where so many travellers from all quarters are either resident or occasional visitors.

46. *Population of Russia, and Instances of Longevity.*—In the year 1817, the number of births in Russia is stated at 786,810 boys, and 711,796 girls; the number of deaths at 423,092 males, and 405,469 females, of whom 208,954 died under five years of age. The increase of population was 670,045. The number of individuals who had attained the age of

60 years, was	68,723
70	38,764
80	16,175
90	2,108
100	783
115	83
120	51
125	21
130	7
135	1
140	1
Total,	126,717

which is about a seventh part of the deaths.

47. *Cases of recovery from Suspended Animation.*—In the year 1820, no fewer than 260 persons were submerged in the Seine at Paris, only 70 of which were accidental. Of these 62 were taken out and restored to life. But out of the whole 260, there were only 86 who had remained *less than twelve hours* under water. Hence out of the number of persons who could be expected to recover, the ratio was as 60 to 86, or as 5 to 7 nearly. A set of Newfoundland dogs is now trained for the purpose of diving for persons submerged in the Seine, and rescuing those who are in danger of being drowned.

48. *Fermenting Pond in Massachusets.*—A remarkable pond has been lately observed in Sharon, Massachusets, known by the name of Mash-Bog Pond, from which great quantities of lenticular argillaceous oxide of iron and cake-ore are procured. From about the middle of August to some time in September, this pond presents the singular appearance of working or fermenting as beer does when new.—Silliman's *Journal*, vol. v. p. 199.

49. *Singular cases of the effects of Nitrous Oxide.*—The following very remarkable cases of the effects of nitrous oxide occurred among Professor Silliman's students, at Yale College. A

gentleman, about nineteen years of age, of a sanguine temperament, and cheerful temper, and in the most perfect health, inhaled the gas, which was prepared and administered in the usual dose and manner. Immediately, his feelings were uncommonly elevated, so that (as he expressed it) he could "not refrain from dancing and shouting." To such a degree was he excited, that he was thrown into a frightful delirium, and his exertions became so violent, that he sunk to the earth exhausted; and having there remained till he in some degree recovered his strength, he again rose only to renew the most convulsive muscular efforts, and the most piercing screams and cries, until, overpowered by the intensity of the paroxysms, he again fell to the ground apparently senseless, and panting vehemently. For the space of two hours these symptoms continued; he was perfectly unconscious of what he was *doing*, and was in every respect like a maniac: he states, however, that *his feelings* vibrated between perfect happiness, and the most consummate misery. After the first violent effects had subsided, he was obliged to lie down two or three times, from excessive fatigue, although he was immediately aroused upon any one's entering the room. The effects remained in a degree for two or three days, accompanied by a hoarseness, which he attributed to the exertions made while under the influence of the gas.

The other case was that of a man of mature, age, and of a grave character. For nearly two years previous to his taking the gas, his health had been very delicate, and his mind so gloomy and depressed, that he was obliged almost entirely to discontinue his studies. In this state of debility, he inhaled about three quarts of the nitrous oxide. The consequences were, an astonishing invigoration of his whole system, and the most exquisite perception of delight. These were manifested by an uncommon disposition for mirth and pleasantry, and by extraordinary muscular power. The effects of the gas were felt, without diminution, for at least thirty hours, and in a greater or less degree, for more than a week; but the most remarkable effect was *upon the organs of taste.* Before taking the gas, he felt no peculiar choice in the articles of food, but immediately after that event, he *manifested a taste for such things only as were sweet*, and for several days *ate nothing but*

sweet-cake. Indeed, this singular taste was carried to such excess, that he *used sugar and molasses not only upon his bread and butter, and lighter food, but upon his meat and vegetables*; and this he continues to do at the present time, although nearly eight days have elapsed since he inhaled the gas. His health and spirits, since that time, have been uniformly good, and he attributes the restoration of his strength and mental energy to the influence of the nitrous oxide. He is quite regular in his mind, and now experiences no uncommon exhilaration, but is habitually cheerful, while before he was habitually grave, and even to a degree gloomy.

50. *Observations in Greece by Mr Hughes.*—Mr Hughes found, not far from Pollina (the ancient Apollonia) in Albania, a desert place, from the fissures of whose surface an empyreumatic vapour arose, which took fire on the application of a taper, and burnt for some time. From the neighbouring ruins, he inferred that they belonged to that oracle described by Dion Cassius, xii. 45. Mineral-pitch is found in abundance in the vicinity. In other sacred places in Greece, as at Delphi and Dodona, where mineral vapours were used in their oracular contrivances, these vapours have disappeared. In the height of Parnassus, where the remains of the Delphic oracles are found, the celebrated *foramina* (where carbonic acid rose from the fissures of the limestone) have been filled; and in place of the springs with inflammable gas at Dodona, (*Vid. Plin. Hist. Nat.* vol. ii. p. 104), we find it at present near Joannina, along with the remains of the temple, simply a marsh. The water of the Grecian Acheron (modern Sali) is no longer bitter, but of an agreeable and fresh taste; only in the place where the muddy *Cocytus* (modern Baba) flows into it, there is formed a standing water, which spreads around an unhealthy air (malaria), which occasions the pale and emaciated appearance of the Albanian peasants in the plains of Phanari.

51. *Copy of the Mahabarat, the great Sanscrit Epic Poem, presented to the Museum of the University of Edinburgh, by* Colonel Walker, *Governor of St Helena.*—Colonel Walker, of Bowland, lately appointed Governor of St Helena, has presented to the College Museum a complete copy of the *Mahabarat*, the great Sanscrit epic poem, composed, or more probably col-

lected, by Vyasa,—to whom are also ascribed the *Puranas*, the Sacred Books of Hindostan. This poem, which consists of above 100,000 metrical stanzas, contains the history of the two great collateral branches of the House of Bharat, the Kurus, and Pandus, well known in Indian mythology. This mythology is, by its admirers, considered as entirely allegorical; and the struggles between the Kurus and the Pandus are by them interpreted as the struggles which are maintained between the Virtues and the Vices of the human character. The *Mahabarat* is known to the English reader, through the translation of one of its most splendid episodes by Dr Wilkins, under the title of "Bhagavat Geeta, or Dialogues of Krisha and Arjun." Mr Hastings, in his prefatory recommendation of that work, expresses himself thus: "I hesitate not to pronounce the Geeta a performance of great originality,—of a sublimity of conception, reasoning, and diction, almost unequalled; and a single exception, among all the known religions of mankind, of a theology accurately corresponding with that of the Christian dispensation, and most powerfully illustrating its fundamental doctrines. It will not be fair to try its relative worth by a comparison with the original text of the first standards of European composition: but let these be taken even in the most esteemed of their prose translations, and in that equal scale let their merits be weighed, I should not fear to place, in opposition to the best French versions of the most admired passages of the Iliad or Odyssey, or of the first and sixth books of our own Milton, highly as I venerate the latter, the English translation of the Mahabarat."

We rejoice that, through Colonel Walker's liberality, our University is enriched with an entire copy of a work thus eulogized by a most competent and enlightened judge. The MS. is in perfect preservation, and is very distinctly written. Colonel Walker accompanied this splendid gift with a portfolio containing some very elegant specimens of ornamental penmanship in Arabic and Persian.

52. *Society of Arts for Scotland.*—As this Society is now holding its meetings, the authors of new inventions or processes are requested to transmit them, free of expence, to the Secretaries, John Robison, Esq. 16. Coates Crescent, to T. G. Wright, Esq. Charlotte Square, Edinburgh.

Art. XXXI.—*List of Patents granted in Scotland from 29th August to 14th November* 1822.

21. To Richard Ormrod of Manchester, county of Lancaster, ironmonger, for an invention communicated to him by a foreigner, of an "improvement in the mode of heating liquids in boilers, and thereby accelerating and increasing the production of steam." Sealed at Edinburgh 4th October 1822.

22. To John Bourdieu of Leine Street, London, Esq. for an invention communicated to him by a foreigner, "of a method or means of improving the preparation of colours for printing wove cloths." Sealed at Edinburgh 21st October 1822.

23. To Mark Isambard Brunel of Chelsea, county of Middlesex, Engineer, for an invention of "certain improvements on steam-engines." Sealed at Edinburgh 21st October 1822.

24. To Pierre Erard of Great Marlborough Street, county of Middlesex, musical instrument-maker, for an invention in part communicated by a foreigner, and in part invented by himself, "of certain improvements on harps." Sealed at Edinburgh 29th October 1822.

25. To Samuel Hall of Basford, county of Nottingham, bleacher, for an invention of "an improvement in the manufacture of starch." Sealed at Edinburgh 4th November 1822.

26. To Richard Roberts of Manchester, county of Lancaster, Civil Engineer, for an invention "of certain machinery or implements applicable to the processes of weaving plain or figured cloths or fabrics, which may be used on, or in conjunction with, looms now in common use; and also certain improvements in the construction of looms for weaving plain and figured cloths or fabrics, and in the method of working looms, either by hand, by steam, or other power." Sealed at Edinburgh 14th November 1822.

P. Neill, Printer, Edinburgh.

THE

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PHILOSOPHICAL JOURNAL.

ART. I.—*Biographical Account of* Sir WILLIAM HERSCHEL, Knight Guelph. LL.D. F.R.S., &c. &c.

AMONG the philosophers who adorned the close of the last century, there are none whose history excites a more varied and intense interest than that of Dr Herschel. Educated under circumstances by no means favourable to the development of great powers, the ardour of his mind surmounted every opposing difficulty, and from a humble, though respectable, station in life, he raised himself to a rank in society which Genius, when directed and sustained by Virtue, seldom fails to reach. Though his scientific studies did not commence till he had arrived at the middle period of life, yet he pursued them with all the energy of youthful devotion, and with that dauntless perseverance which renders genius almost omnipotent. Every step, indeed, of his astronomical career, was marked with discoveries of the most splendid character. New Planets, new Satellites, new celestial bodies, were successively presented to Science, and Man was enabled to extend the power of his senses, as well as the energy of his reason, to those remote regions of space, where his imagination had hitherto scarcely dared to wander. His Invention of Instruments, and methods of observation, too, was no less surprising than the wonders which they disclosed. Obstacles insuperable to other men he speedily surmounted. The Telescope, which Galileo held in his hand as a portable toy, be-

came, under Dr Herschel's direction, a machine which supported the astronomer himself, and which mechanical energy was requisite even to move. There was no continuity, in short, between his inventions and discoveries, and those of preceding astronomers. He adventured upon a flight, which left them at an immeasurable distance, and he penetrated into regions, where the ablest of his successors will have some difficulty in following him.

The History of Dr Herschel's Discoveries, therefore, must possess a high interest even for those who are not profoundly versed in astronomy; while it may be studied with peculiar advantage by the young philosopher, who aspires to the renown which now dignifies his venerable name.

Sir WILLIAM HERSCHEL was born in Hanover, on the 15th November 1738. His father, who was a musician, dedicated his five sons to the same profession. William, who was the second, was placed, at the early age of fourteen, in the band of the Hanoverian Foot Guards; but looking forward to a better sphere for the exercise of his talents, he resolved to seek his fortune in England, where he arrived about the end of the year 1757. After encountering the usual difficulties which mark the early career of genius, the Earl of Darlington engaged him to superintend the instruction of a military band, which he was then forming in the county of Durham. In this situation he formed many useful connections; and when his engagement with Lord Darlington was completed, he established himself, as a teacher of music, in the neighbourhood of Leeds, Pontrefact and Doncaster, where he met with much success, and conducted the public concerts and oratorios in these towns.

In the year 1766 he was appointed organist at Halifax, but he soon afterwards received a more lucrative situation of the same kind in the Octagon Chapel at Bath. Here his musical talents were fully appreciated; and, as a private teacher of music, and a director of the public concerts, he enjoyed an income considerably above his wants.

Enthusiastically devoted as he was to his profession, his ardent mind had long been applying itself to still higher pursuits. He had acquired, by his own industry, a considerable know-

ledge of mathematics, while residing at Halifax; but the doctrines of astronomy had, in an especial manner, fixed his attention, and while he studied, in the popular writings of Ferguson, the wonders of the planetary system, as disclosed by the telescope, he was actuated by the most vehement desire of witnessing, with his own eyes, such remarkable phenomena. The price of a telescope capable of exhibiting the most interesting of the planetary phenomena, was, luckily for science, far beyond the means of Mr Herschel; but his zeal was not to be damped by a difficulty of this nature, and he resolved to construct a telescope with his own hands. After encountering and overcoming the difficulties which every amateur must have experienced in the formation of reflecting telescopes, he completed, in 1774, a five feet reflector, with which he observed the ring of Saturn, and the satellites of Jupiter. "When I resided at Bath," says Dr Herschel, "I had long been acquainted with the theory of optics and mechanics, and wanted only that experience which is so necessary in the practical part of these sciences. This I acquired by degrees at that place, where, in my leisure hours, by way of amusement, I made for myself several 2-feet, 5-feet, 7-feet, 10-feet, and 20-feet Newtonian Telescopes, besides others of the Gregorian form, of 8 inches, 12 inches, 2 feet, 3 feet, 5 feet, and 10 feet focal length. My way of doing these instruments at that time, when the direct method of giving the figure of any one of the conic sections to specula was still unknown to me, was to have many mirrors of each sort cast, and to finish them all as well as I could, then to select by trial the best of them, which I preserved; the rest were put by to be repolished. In this manner I made not less than 200 7-feet, 150 10-feet, and about 80 20-feet, not to mention those of the Gregorian form, or of the construction of Dr Smith's reflecting microscope, of which I also made a great number. My mechanical amusements went hand in hand with the optical ones. The number of stands I invented for those telescopes it would not be easy to assign. I contrived and delineated them of different forms, and executed the most promising of the designs. To those labours we owe my 7-feet Newtonian telescope stand, which was brought to its present convenient construction about 1778."—*Phil. Trans* 1795, p. 347.

With these instruments Mr Herschel examined the Heavens with much assiduity and success. His first observations, made in 1776, and subsequent years, were published in the *Philosophical Transactions* for 1780 *, and related to the "*Periodical Star in the Neck of the Whale*," and to the "*Height of the Lunar Mountains.*" The next paper which he communicated to the Royal Society in 1781, was entitled "*Observations on the Rotation of the Planets round their axes, made with a view to determine whether the Earth's diurnal motion is perfectly equable;*" and he soon after laid before that learned body his *Account of a Comet* observed on the 13th March 1781, which afterwards proved to be a new planet, which he distinguished by the name of the Georgium Sidus, in honour of his late Majesty.

The news of this most important discovery spread rapidly over Europe. The astronomers of every country looked forward with the highest expectations to the future labours of the successful discoverer, and the name of Mr Herschel became known wherever the science of the heavens was cultivated. His Gracious Majesty George III., animated with the munificent spirit of a British Sovereign, relieved Mr Herschel from his professional labours, and enabled him, by the grant of a handsome salary, to devote the remainder of his days to the examination of the heavens. In consequence of this arrangement, so fortunate for astronomy, Mr Herschel took up his residence at Datchet, in the neighbourhood of Windsor, where he pursued his observations with diligence and zeal, and began a series of discoveries, which are without a parallel in the history of astronomy.

In 1781, Mr Herschel published a description of "*A Micrometer for taking the Angle of Position,*" or the angle formed by a line joining two stars with the direction of their motion; and in 1782, in a paper on the "*Parallax of the Fixed Stars,*" he resumed and explained the method proposed by Galileo, of measuring the angular distance of two contiguous fixed stars, without obtaining any results of importance, in so far as the parallax itself

* Mr Herschel communicated to the Philosophical Society at Bath, in 1780 and 1781, several mathematical papers on the effects of diversified central powers of attraction and repulsion, [illegible] formation of clusters of stars.

was concerned. As the observations of double stars, however, presented great facilities for carrying on this inquiry, he devoted himself with much patience to the examination of this class of phenomena; and, in the same year, he published, in the *Philosophical Transactions*, his "*Catalogue of Double, Triple, Quadruple, and Multiple Stars*," a work which would have given immortality to an astronomer of any age. In order to measure the angular distance of two stars extremely near each other, he invented his *Lamp Micrometer*, which appeared in the Transactions of the same year

Dr Herschel's attention was now directed to a subject of deep interest to astronomy. The celebrated Tobias Mayer was the first person who gave an explanation of the proper motion of the fixed stars, as first observed by Halley, and afterwards by Lemonnier and Cassini; but the honour was reserved for Dr Herschel to point out the direction as well as the magnitude of their proper motion. By a comparison of the proper motion of the fixed stars, Dr Herschel discovered that the solar system is advancing to *Hercules* He supposes that this motion is not rectilineal, but is performed round some distant centre, and though he has endeavoured to determine the velocity with which it moves, yet many ages must elapse before this inquiry can be crowred with complete success The paper containing these investigations, is published in the *Transactions* for 1783, and is entitled, "*On the Proper motion of the Sun and Solar System, with an account of several changes that have happened among the Fixed Stars since the time of Mr Flamstead.*"

Between the years 1777 and 1783, Dr Herschel made some interesting discoveries respecting the planet Mars. The luminous zone which had often been observed at the southern pole of the planet, he found to arise from the reflection of the sun's light, from its frozen regions In 1781, when its polar zone had not experienced the influence of the sun for twelve months, the south polar spot was of great magnitude, and in 1783 it had suffered a very great diminution from an exposure of eight months to the solar rays. Our author likewise determined, that the equatorial was to the polar diameter of the planet as 16 to 15 nearly, and that the period of his daily revolution was about $24^h\ 39'$ These curious results were communicated to the Royal

Society in 1787, under the title of "*On the appearance of the Polar Regions of the Planet Mars*," &c.

With the view of examining the structure and arrangement of the starry heavens, Dr Herschel had now completed a 20-feet Newtonian telescope, with an aperture of $18\frac{7}{10}$th inches. The apparatus on which it was mounted, was contrived so as to confine the telescope to a meridional situation, and, by its motions, to give the right ascension and declination of a celestial object in a coarse way. By this instrument, he examined all the clusters of stars and nebulæ which Messier and Mechain had published in the *Connoissance des Tems* for 1783 and 1784, and he found that they could almost all be resolved into an infinite number of small stars. Upon applying the telescope to the part of the Milky Way about the Hand and Club of Orion, which his former telescopes had not light enough to analyse, he was astonished at the "glorious multitude of stars, of all possible sizes, that presented themselves to his view," and he reckoned that a belt 15 degrees long by 2 broad, contained no less than 50,000 stars that could be distinctly numbered. In pursuing these observations, Dr Herschel discovered no fewer than 466 new nebulæ, which he often found arranged in strata, and so thickly, that he detected 31 nebulæ which passed through the field of view in 36 minutes. The most interesting result, however, to which these observations led, was the theory of the Milky Way, which Dr Herschel considers as an extensive branching congeries or nebula of many millions of stars, within which our own Solar System is placed, the luminous tracks which constitute the Galaxy, being the projection of the nebula upon the concave surface of the sky, as seen from the solar system which it incloses. In order to determine the position of the sun within the nebula, as well as the form of the nebula itself, Dr Herschel *gauged the heavens* in various parts of the Milky Way. This process consisted in repeatedly counting the number of stars in *ten* fields of view near each other, and taking the mean of their numbers for the number of stars in that part of the Galaxy. Upon the supposition that the stars are equally scattered, the above mean enabled him to deduce the length of his visual ray, or the distance through which his telescope has penetrated, or, what amounts to the same thing, the distance of the

remotest stars in that particular part of the heavens. Hence he was able to deduce the probable form of the Milky Way, and the probable situation of the solar system within it. These interesting views are recorded in two Memoirs, "*On the Construction of the Heavens*," published in the *Philosophical Transactions* for 1784 and 1785.

In the year 1786, Dr Herschel presented to the Royal Society "*A Catalogue of* 1000 *new Nebulæ and Clusters of Stars*," which he had observed with his 20-feet reflector since 1783, and this was followed in 1789 by "*A Catalogue of a second* 1000 *new Nebulæ and Clusters of Stars, with a few introductory remarks on the Construction of the Heavens*." Having shewn that clusters of stars and these round nebulæ, to the amount of 2300, are either of a spherical form, or are more condensed or brighter in the middle, Dr Herschel considers that this arrangement is owing to a central power residing in the brightest portion. The clusters which have the most perfect spherical figures, he supposes to have been longest exposed to the action of these forces, and he conceives that we may judge of the relative age and maturity of a sidereal system, from the disposition of its component parts, and that the same reasoning may be extended to nebulæ, the degrees of brightness being supposed equivalent to the different accumulation of the stars in clusters. A cluster or nebula which is gradually more compressed and bright towards the middle, may be in the perfection of its growth, while others, such as those called Planetary, where the compression is more equal, may be regarded as very aged, and approaching to a period of change or dissolution.

These speculations, ingenious and sublime as they are, excited less notice than the positive and important discoveries by which they were followed. Dr Herschel had now introduced the method of observing which he calls the *Front View*, which consists in laying aside the small speculum, and observing directly with an eye-glass the image formed by the large speculum. By this means he gained all the light (amounting nearly to one-half,) which was lost by reflexion, and he was particularly struck with the brightness and the facility with which he saw nebulæ that he had observed in former surveys. He then thought of examining the *Georgium Sidus* by that new

method, and on the 11th January 1787, he was rewarded by the discovery of two of the satellites of that planet, viz. the *second* and *fourth*. In 1790 and 1794, he discovered other four satellites, viz. the *first*, *third*, *fifth*, and *sixth*, all of which have the remarkable character of moving in a retrograde direction, and in orbits nearly in the same plane, and almost perpendicular to the ecliptic.

Not content with the instruments which conducted him to these magnificent discoveries, Dr Herschel resolved to construct telescopes of a still larger size. In 1781 he began a 30 feet aerial reflector, but his mirror, 36 inches in diameter, having at one time cracked in the cooling, and at another run into the fire, from a failure in the furnace, his project failed for a time. The plan of forming a telescope of extraordinary size having been submitted by Sir Joseph Banks to King George III., that munificent Sovereign instantly offered to defray the expence of it, and, under his august patronage, Mr Herschel began, about the end of the year 1785, to construct a telescope forty feet in focal length. The great speculum was $49\frac{1}{2}$ inches in diameter, its polished surface 48 inches,—its thickness $3\frac{1}{2}$ inches, and its weight, when newly cast, 2118 lb. The tube was 39 feet 4 inches long, and 4 feet 10 inches in diameter, and every part of it was made of rolled or sheet iron, united without rivets, by a species of seaming used in making the iron-funnels for stoves. The thickness of the iron was less than the 36th part of an inch, and a square foot weighed about 14 ounces. Hence, it was so light, that a wooden one would have exceeded it in weight at least 1000 pounds. This splendid instrument, which magnifies 6450 times, was completed on the 27th August 1789, and on the day following Dr Herschel discovered a new satellite belonging to the planet Saturn. Soon afterwards, in the same year, he discovered a second new Satellite of Saturn, and he found that both of them were situated nearer the planet than the five old ones, though he found it convenient to call them the *Sixth* and *Seventh* Satellites. On the 14th September 1789, Dr Herschel found that the equatorial was to the polar diameter of Saturn as 11 to 10. He observed also belts parallel to the ring, and he concluded from this, and a change in the position of the spots, that the planet revolved round an axis perpendicular to the plane of the ring

In the year 1791, he measured with great accuracy the dimensions of the ring. He observed a variation in the light of the *fifth* satellite, and concluded that it moved round its axis in the same time that it revolved round the planet. He discovered, in 1793, a quintuple belt, three of its component belts being dark, and two bright, and he soon afterwards determined the diurnal rotation of Saturn to be $10^h\ 16'$.

From the condition of the planetary bodies, Dr Herschel next proceeded to examine "*The Nature and Construction of the Sun and the Fixed Stars*," and he published the results of his observations in the *Philosophical Transactions* for 1795. Considering the surface of the sun as composed of luminous clouds floating in the solar atmosphere, and the dark nucleus of the spots as the opaque body of the sun seen through the openings in his atmosphere, Dr Herschel imagined that the functions of the great luminary, as the source of light and heat, may be performed by the agency of its external atmosphere alone, while the solid nucleus below, protected by clouds from the glowing element above, is possibly reserved and fitted for the reception of living beings. If this hypothesis be supported by no direct analogies, it may be attributed to the singular nature of the phenomenon it is formed to explain. It contains, at least, nothing contrary to sound philosophy (which cannot be said of any of the wild speculations advanced on this subject by his predecessors); and the appearances of the solar disc are precisely such as ought to take place on the supposition of its truth. Such views serve to enlarge our conceptions of the Supreme Being, who, in every star that sparkles in the firmament, has dispensed the blessings of life and intelligence to various orders of animated beings.

In the year 1796, Dr Herschel communicated to the Royal Society his "*Method of observing the Changes which happen to the Fixed Stars, with some Remarks on the Stability of the Light of our Sun*;" to which he added "*A Catalogue of Comparative Brightness, for ascertaining the Permanency of the Lustre of Stars.*" This catalogue was followed in the same year by a *Second Catalogue*, along with remarks, tending to establish the rotatory motion of the stars on their axes; in 1797 by a *Third Catalogue* of the same kind; and in 1799 by a *Fourth*

Catalogue. The object of this investigation was to determine the extent and nature of the changes that take place among the fixed stars; and the method of comparing their relative lustres employed by our author, is admirably adapted for this purpose. The deductions, however, to which these observations will lead, must belong to another age, when astronomers of equal activity and intelligence shall have marked with the same accuracy the comparative lustre of these distant bodies.

The determination of the variable brightness of the Fifth Satellite of Saturn, led our author to a series of "*Observations on the changeable brightness of the Satellites of Jupiter, and of the variation in their apparent Magnitudes, with a determination of the Time of their rotatory motion on their axes.*" This interesting memoir, which appeared in the Transactions for 1797, contains many curious results. It proves beyond a doubt, that considerable changes take place in the brightness of the satellites;—that the 1st satellite is white (sometimes to a very intense degree); the 2d white, bluish, and ash-coloured; the 3d always white; and the 4th of a dingy orange, or sometimes reddish; —that the 3d satellite is the largest; the 1st a little larger than the 2d, and nearly of the size of the 4th; and the 2d a little smaller than the 1st and 4th, or the smallest of them all. It appears also extremely probable, that all the satellites revolve about their axes in the same time that they perform their periodical revolution about the planet.

Hitherto it had been supposed, that a telescope afforded a distinct view of remote objects, merely by presenting a magnified picture to the eye; but Dr Herschel was led by an accidental experiment, to notice a peculiarity in their mode of action, which he has designated by the name of the *power of penetrating into space.* When he viewed in the dusk of the evening the dial of a distant steeple, he was able to observe the hour of the day, though the steeple itself was invisible to his naked eye. Hence he concluded, that though magnifying power was necessary to see the hours on the dial-plate, yet none was required to see the steeple itself; and therefore that the telescope had a power of penetrating into space. The use of night glasses with large apertures was no doubt suggested by the practical knowledge of this principle, and it is not difficult to

understand how the quantity of faint light from the steeple, that passed through the pupil of the unassisted eye, should be incapable of performing the functions of vision, while a quantity of the same light, falling on a speculum twelve inches in diameter, was perfectly sufficient to render the same object distinctly visible. This interesting subject Dr Herschel has treated with great perspicuity in his paper "*On the Power of penetrating into Space by Telescopes, with a comparative determination of the extent of that power in natural vision, and in telescopes of various sizes and constructions,*" which was published in the *Philosophical Transactions* for 1800.

Hitherto we have followed our author in his varied excursions among the bodies of the solar system, and among the intricate phenomena of the starry heavens; but we shall now trace him into a new field of discovery, which he has rendered one of the most fertile and interesting in general physics. While engaged in experiments on the most advantageous methods of viewing the sun with large telescopes, he had occasion to employ various combinations of differently coloured darkening glasses. With some of these he felt a sensation of heat when there was very little light, while others gave him much light with scarcely any sensation of heat. The sun's image being in these cases differently coloured, it occurred to Dr Herschel, that the prismatic rays might have the power of heating in a very unequal degree; and he immediately projected a series of experiments on that subject. He found that the heating power of the rays of the prismatic spectrum, increased gradually from the extremity of the violet space to the extremity of the red space, whereas the power of illuminating objects was a maximum in the yellow rays, and decreased towards both extremities of the spectrum. In measuring the heating power of the red rays, he was surprised to find that the thermometer still rose when it was placed a little without the red extremity of the spectrum, and he was thus led to the curious and important discovery *of invisible rays beyond the red space, which had the power of heating but not of illuminating objects.* The invisible heat exerted a considerable power over the thermometer even at a point 1½ inches beyond the extreme red, when the distance of the spectrum from the prism was 52 inches.

This splendid discovery excited great interest throughout all Europe. Sir Humphry Davy, Sir Henry Englefield, M. Berard, and many other philosophers of distinction, repeated the experiments with perfect success; and Dr Wollaston, M. Ritter and M. Bockmann were conducted, during the repetition of Dr Herschel's experiments, to the discovery of the chemical or deoxidating rays, at the opposite end of the spectrum. Amid the general applause with which these great accessions to science were received, one dissentient voice alone was heard. An individual whose speculations the discovery of Invisible Solar Heat had cast into the shade, attacked Dr Herschel with an asperity far beyond the limits even of severe criticism; but though that venerable man often spoke, with suppressed feelings, of the attempt which was thus made to discredit and depreciate his labours; yet he never condescended to repel the charge; and he had the satisfaction before he died of seeing his own discoveries universally received among the established principles of Physics, while those of his assailant were rejected by philosophers of every cast, both in the Old and in the New World *.

The discoveries of Dr Herschel, which we have now recorded, terminated his labours in the eighteenth century, and may be considered as the capital of that triumphal pillar which he has reared for himself in the Temple of Science. He had now reached his sixty-second year, that period of life when the ambition of discovery is at least mellowed, if not in some degree replaced, by more serious principles of action; and though he afterwards enriched the Philosophical Transactions with numerous communications of great value, yet they were less

* The discoveries of Dr Herschel, respecting the Prismatic Spectrum, are contained in three Memoirs, which are printed in the Philosophical Transactions for 1800, under the following titles:

1. *Investigation of the powers of the Prismatic Colours to heat and illuminate objects; with remarks that prove the different refrangibility of radiant heat.*—Phil Trans. 1800, p. 255.

2. *Experiments on the refrangibility of the invisible rays of the Sun.*—Id. p. 284

3. *Experiments on the solar, and on the terrestrial rays that occasion heat, with a comparative view of the laws to which light and heat,* or *rather the rays which occasion them, are subject, in order to determine whether they are the same or different.*—Part I. *Phil. Trans.* p. 293. Part II. *Phil. Trans.* p. 437

marked with the impress of discovery, than those which preceded them.

In the year 1801, he published his "*Observations tending to investigate the nature of the Sun, in order to find the causes or symptoms of its variable emission of Light and Heat.*" After describing and giving appropriate names to the different phenomena which appear on the surface of the sun, he considers the non-existence of spots, &c., as a sign of a scarcity of luminous matter in the sun, and he states it as his opinion that the character of the seasons may depend on these phenomena. Hence, he is led to support this hypothesis by comparing the solar appearances as given by Lalande, with the prices of wheat during the same periods, as contained in Dr Smith's Wealth of Nations. In the observations which this paper contains, he found that the sun could be seen as white as snow, by observing him through a stratum of ink diluted with water, and filtered through paper.

The discovery of the two new planets Ceres and Pallas by Piazzi and Dr Olbers, afforded Dr Herschel an opportunity of observing them with his fine instruments. An account of these observations, he published at great length in his paper, "*On the two lately discovered Celestial Bodies*" in the *Philosophical Transactions* for 1802. He found the diameter of Ceres to be 163 miles, and that of Pallas 110,—he gave them the name of Asteroids, from their resemblance both to planets and comets, and he predicted that many others would be discovered,—a prediction which was soon after verified by the discovery of Juno and Vesta, in the very same part of the system. His observations on Juno appeared in the Philosophical Transactions for 1805, and those on Vesta, in the same work for 1807.

In the same year, Dr Herschel published his "*Remarks on the Construction of the Heavens.*" The parts which enter into the construction of the Heavens, he arranges under, 1. Insulated Stars; 2. Binary Sidereal Systems, or Double Stars; 3. More Complicated Sidereal Systems, or Treble, Quadruple, Quintuple and Multiple Stars; 4. Clustering Stars, and the Milky Way; 5. Groups of Stars; 6. Clusters of Stars; 7. Nebulæ; 8. Stars with Burs, or Stellar Nebulæ; 9. Milky Nebulosity; 10. Nebulous Stars;

11. Planetary Nebulæ; and 12. Planetary Nebulæ with Centres. He considers it highly improbable, that Double Stars should consist of Stars at a considerable distance; and he thence supposes that they have a motion of rotation round their common centre of gravity. The same reasoning he extends to the more Complicated Sidereal Systems, and he shews how three or more Stars may be preserved in a permanent connection, by revolving in proper orbits round a common centre of motion. This curious paper, which possesses a very considerable degree of interest, is concluded with a "*Catalogue of 500 new Nebulæ, Nebulous Stars, Planetary Nebulæ, and Clusters of Stars.*"

The views contained in this paper received a very remarkable confirmation, from a new discovery of our author. In more than fifty of the double stars, he found that during twenty-five years a change had taken place, either in the distance of the two stars, or in the *angle of position*, the angle that a line joining the two stars forms with the direction of their daily motion. In *Castor*, ε *Bootis*, δ *Serpentis*, and γ *Virginis*, the angle of position had suffered a very considerable variation, without any change taking place in the distance of the stars, while in γ *Leonis*, both the distance and the angle of position had changed, and in ζ *Herculis*, the two stars had approached so near to each other, that five-eighths of the apparent diameter of the small star was actually eclipsed by the large one. With regard to *Castor*, the most remarkable of these double stars, Dr Bradley had observed, in 1759, that the line joining the two stars was, at all times of the year, parallel to the line joining *Castor* and *Pollux*; whereas, in 1803, Dr Herschel found that these two lines formed with each other an angle of 45° 39′, giving for the time of a whole apparent revolution of the small star round Castor 342 years and 2 months. This interesting inquiry will be found in the *Philosophical Transactions* for 1803.

The motion of the Solar System in absolute space, the general direction of which he had determined in 1783, again occupied the attention of Dr Herschel, and he has published the results of a very elaborate inquiry in the *Philosophical Transactions* for 1805, under the title of "*On the Direction and Velocity of the Motion of the Sun and Solar System*;" and, in the same work for 1806, "*On the Quantity and Velocity of*

the Solar Motion." In the first of these memoirs, he concludes that the direction of the solar motion is towards a point in the heavens, whose right ascension is 245° 52′ 30″, and whose north polar distance is 40° 22′. In the second memoir, he concludes that the quantity of the solar motion is such, that, by an eye placed at right angles to its direction, and at the distance of *Sirius* from us, the sun would be seen to describe annually an arch of 1″.116992 of a degree.

In the examination of the planet Saturn, Dr Herschel had considered it as of a spheroidal figure, but more correct observations had indicated to him a considerable irregularity of form, and he has given a detailed account of them in two papers, one published in the Transactions for 1805, entitled "*Observations on the Singular Figure of the Planet Saturn,*" and the other, in the same work for 1808, entitled "*An Account of a New Irregularity lately perceived in the apparent figure of the Planet Saturn.*" In the first of these papers, he shews that the equatorial diameter is 35, and the polar diameter 32, but that the diameter of the greatest curvature is 36, which falls in the latitude of 43° 20′. In the second paper, he states that the northern polar regions were flattened, as formerly, but that the southern polar regions were more curved, or bulged outwards. The same peculiarity was observed, at Dr Herschel's request, by the late Professor Wilson; but both astronomers regarded it as an illusion, and our author ascribed it to the position of the ring between the eye and the southern pole, the rays of light being supposed to be acted upon by the atmosphere of the ring, of which he had previously observed the effects.

The subject of the construction of the heavens, which Dr Herschel had made entirely his own, formed the principal topic of all the subsequent communications of importance, which he laid before the Royal Society. In 1814, he published in the Transactions his "*Astronomical Observations relating to the sidereal part of the Heavens, and its connexion with the nebulous part.*" He supposes, in this paper, that the various nebulosities which fill the heavens, are condensed by attraction, and converted into stars; that stars previously formed sometimes attract nebulous matter, and increase in size, and that neighbouring stars gradually approach each other, and constitute globular clusters.

This paper was followed, in 1817, by "*Observations tending to investigate the local arrangement of the Celestial Bodies in space, and to determine the extent and condition of the Milky Way,*" which contains much interesting discussion, and in which its author concludes, that not only our sun, but all the stars we can see with the eye, are deeply immersed in the milky way, and form a component part of that immense nebula.

The last paper which Dr Herschel wrote on this subject, and indeed the last which he communicated to the Royal Society, was entitled "*Astronomical Observations and Experiments selected for the purpose of ascertaining the relative distances of Clusters of Stars, and of investigating how far the power of our Telescopes may be expected to reach into space, when directed to ambiguous celestial objects.*" From these observations, our author concludes, that a star of the first magnitude would just come to be visible by the naked eye, if removed to 12 times its distance, and by the most powerful telescope hitherto constructed, if removed to 2300 times its distance. Yet such a telescope still shews stars in the milky way at the utmost limits of their visibility. This extraordinary assemblage of stars is therefore equally fathomless by our eyes and by our finest telescopes. Conceiving, however, that the united lustre of sidereal systems may reach us from a still greater distance in space, Dr Herschel estimates their distance by the aperture of the speculum, which just resolves them into stars, and in this way he has estimated the distances of 47 clusters. Such clusters are again taken as connecting links with such *ambiguous objects* as cannot be resolved by the telescope. Resolvable clusters are actually found to put on similar appearances with inferior telescopes, and hence we may compare their distances with those of the former kind, by the same principles as those with the nearest fixed star. When objects of this kind are lost to the sight, the utmost limits of human vision seem to be obtained, and our author supposes that this must take place at about the 35,000th order of distances.

In consequence of the great reputation which Dr Herschel's telescopes possessed, he received numerous applications for instruments, from the sovereigns, as well as from the astronomers

of foreign countries. His time was accordingly much occupied in superintending the construction of these instruments, as well as of those which he required for his own use. He was therefore possessed of a body of practical information on the subject of grinding and polishing specula, and he composed a work on the subject, in which he explained not only the method of giving them the parabolic figure, but that of any of the other conic sections. His intention of publishing this work he mentioned in a letter to the writer of this sketch, in the beginning of 1805; but it has not yet been given to the public.

We have thus endeavoured to give a rapid sketch of the Discoveries of Sir William Herschel,—discoveries which, while they have immortalised his name, have added to the glory of the country where they were made, and to that of the British Sovereign, through whose munificence they were achieved. In the observations upon which these discoveries were founded, and in the laborious calculations which were requisite to their development, he was much assisted by his excellent sister Miss Caroline Herschel, whose cheerful devotion to the cause of science merits the highest praise. Her discovery of several comets has already gained her a respectable rank among astronomers, and on that monument which posterity shall rear to her brother's labours, her own name will be honourably inscribed.

The various marks of respect, unsubstantial as they are, which generally fall to the lot of scientific distinction, were liberally conferred upon Dr Herschel. He was elected an Honorary Member of most of the Scientific Institutions in the civilised world. So early as 1786 or 1787, he received the honorary degree of Doctor of Laws, from one of our English Universities; and in the year 1816, his present Majesty King George IV. was graciously pleased to present him with the Decorations of the Guelphic Order of Knighthood.

Upon the establishment of the Astronomical Society of London in 1820, Sir William Herschel was elected its President, and he published, in 1821, in the first volume of its Transactions, a paper "*On the Places of* 145 *New Double Stars*," which he had intended to arrange like those of his two Cata-

logues already mentioned. This paper was, we believe, the last that Sir William published. His health had now begun to decline, and, on the 25th of August 1822, he sunk under the infirmities of age, after having completed his eighty-fourth year. In 1788 Sir William Herschel married the widow of the late John Pitt, Esq., who has survived him. His union with this lady was to him a source of unclouded happiness, and cherished that tranquillity in his domestic circle, so essential to the peaceful occupations of science. Sir William left behind him an only son, the present Mr John F. W. Herschel *. At an age comparatively early, this eminent individual has taken a high station among the most distinguished mathematicians and natural philosophers of the present day. His name and his discoveries have already adorned our humble pages, and we trust that many of them will yet be occupied in recording his future labours. O.

EDINBURGH, *Feb.* 1. 1823.

ART. II.—*On Fossil Organic Remains as a Geognostic Character.* By ALEXANDER BRONGNIART, Member of the Institute of France, &c. &c. †

IT was remarked more than a hundred years ago, that there almost always occurred differences between the shell-fish and other animals which at present live in the seas and on the surface of the earth, and those which occur in a fossil state in all countries. This first view has been confirmed by a more detailed examination, and has by degrees led to another, which maintains, that the deposits of organic remains buried in the crust of the earth, are arranged, as it were, by successive generations, in such a manner, that all the remains of any one deposit have a

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* A detailed account of Sir William Herschel's Life and Discoveries, with a collection of his best papers, will, we anxiously hope, be soon given to the public by Mr Herschel.

† From Cuvier's work on *Fossil Organic Remains*, in progress of publica-

particular sum of resemblance to one another, and a general sum of difference with the deposits above and below it. It has also been thought, that this last sum becomes so much the higher, or the difference so much the greater, in proportion as these deposits are more distinct or more removed from one another in a vertical direction. This rule, which was at first cautiously assumed, and only for certain localities (as should always be done with the establishment of laws, which can only result from the observation of a great number of facts), has been found applicable to almost all the places observed in the different parts of the globe, and to all the remains of organised bodies buried in its beds, whether they belong to the class of animals or to that of vegetables. To the present time, the exceptions which appear to have presented themselves have vanished under a more scrupulous examination, or are explained by the discovery of particular circumstances which have given rise to them. Thus, on reducing this rule to the general exposition which we have made, it does not appear liable to any real objection, and all geologists are now agreed in thinking, that the generations of organised bodies which have successively inhabited the surface of the earth, differ from the present generation in proportion as their debris are farther removed from the surface of the earth, or, which nearly comes to the same thing, in proportion as the periods at which they have lived are more remote from the present time. It follows from the same rule, that this distinct succession of generations would present itself only in the structure of the crust of the globe. It would also of itself be sufficient to establish the fact, as has been remarked by M. Cuvier, that this crust has not been formed by a single operation. But this character of succession in the formation of the beds of the earth, is frequently associated with other very remarkable differences, such as the nature of rocks, their structure in the great, their known order of superposition, the minerals which accompany them, &c. Now, these mineralogical circumstances are almost always found in agreement with the characters which are taken from the general resemblance of organised bodies in deposits, considered as of the same formation from their geognostical characters; and they are also pretty

constantly found in agreement with their difference in the opposite case.

However, there are cases where these two classes of characters, without being in manifest opposition, do not perfectly agree. Two of these cases present themselves in the two formations which I have referred to the Chlorite Chalk. We must therefore know to which of the two characters the preference should be given, in order to determine the period of formation of the deposit which does not present them associated; that is to say, to reply to the following question:

When, in two deposits separated from each other, the rocks are different in nature, while the organic remains are similar, should these deposits, from this difference, be regarded as of different formation, or should they rather, from the general and well determined resemblance of their fossil organic bodies, be regarded as of the same period of formation, when, at the same time, no circumstance of superposition is evidently in opposition to it?

It must be kept in view, that one of the principal objects of geognosy, is to distinguish the different periods which succeed each other in the formation of the globe, and to determine what are the deposits which have been formed nearly at the same period.

Now, it will be found, that rocks of very different natures may be formed at the same time,—almost at the same moment,—not only in different parts of the globe, but also at the same place.

We cannot refuse our assent to a consequence derived from facts, which we have before our eyes; for all that at present occurs at the surface of the earth, belongs to the same geognostical epoch, which commenced at the moment when our continents assumed their present form: and although this epoch has a character of stability, and even of repose, which permits the formation of new rocks only, in a very limited number of circumstances; it still, however, produces enough to let us see that the trap-rocks formed by Vesuvius, and by the greater number of our volcanoes, the calcareous rocks formed by many of our springs, and the siliceous rocks formed by some others (those of Iceland, &c.), are assuredly very different from one

another, in a mineralogical sense; but that the organic remains which they envelope, have all the common character of the generation established upon the earth, since the commencement of this epoch. To increase the number of examples, and, consequently, proofs of one and the same truth, would be unnecessarily to protract a series of reasonings already somewhat long.

It is not the same with the generations of organised beings; they may, it is true, be destroyed in an instant, but a considerable time must necessarily be taken to reproduce them, so as that they may assume, in number and variety, the development which they commonly present. This development supposes a long series of ages, or at least of years, which establish a true geognostical epoch, during which all the organised bodies which inhabit, if not the whole surface of the globe, at least very extensive tracts of this surface, have assumed a particular family or epochal character, which cannot be defined, but which yet cannot be misunderstood.

I consider, therefore, the characters of the *period of formation*, derived from the analogy of organised bodies, as of the first importance in geognosy, and as sufficient to counterbalance all other differences, however great they appear. Hence, even should the characters taken from the nature of the rocks, and this is the weakest distinctive mark, from the height of the deposits, from the scooping of valleys, even from the inclination of beds, and their unconformable stratification, be found, in opposition to that which we derive from organic remains, I would still consider the latter as of superior validity; for all these differences may be the result of a revolution, and of an instantaneous formation, which do not establish in geognosy a special epoch. Without seeking to prove this principle, by a longer train of reasoning, I shall content myself with citing a single fact. The formations of Calabria have been, for thirty-eight years, the theatre of fearful perturbations. Horizontal beds have been raised to a perpendicular position; entire masses of deposits have been transported to a great distance, and have been placed in unconformable stratification, upon other deposits, and yet no geologist would regard these masses, and these deposits, as belonging to a different geognostic epoch. To produce a change of organic species, circumstances of a very different na-

ture are necessary, phenomena much more general, and periods of time much more considerable. In the course of a few days, the deposits of Calabria have experienced derangements similar to those which we see in the beds of the Alps; and, during a space of five or six thousand years, the organised species have not manifested any appreciable changes in their forms, or other qualities.

I do not, however, say, that the characters taken from the relative disposition of beds (but not from the *evident superposition*), from their nature, &c., should not be employed, even with confidence, by the geologist, in determining the different periods of formation. Whether single or united with those which are derived from the nature of fossil organic bodies, they are of the greatest validity; but I merely think, and I believe I have given strong reasons for my opinion, that when these characters are in opposition to those which may be taken from the presence of fossil organic bodies, these last should have the preference.

I do not deny that much attention and discretion are necessary to be used in such a matter, nor am I ignorant that it is requisite to distinguish and estimate even the influence of horizontal distances, or of climates, upon the specific differences; that we must know to appreciate the apparent, sometimes even real, points of resemblance, which present themselves in formations which are evidently very distinct, in certain species which have had the rather rare privilege of surviving the destruction of their cotemporaries, and of remaining always the same, in the midst of all the changes which have taken place around them. I am not ignorant that we must know to recognise the individuals wrested from other deposits, and transported, by whatever causes, to newer ones, and to distinguish them from those which have lived in the places and times, which the species, to which they belong, ought to characterise. I am aware of all these difficulties; I am on my guard against these causes of deception, which introduce uncertainties into geology, such as we meet in all the sciences, and which require of the geologist unremitting attention and labour, to employ with discernment the species from which he must take his characters, and to attach to them the true value which in reality belongs to them.

Art. III.—*Account of Captain* Hodgson's *Journey to the Head of the Ganges* *.

THIS interesting journey was performed in the year 1817, by Captain Hodgson and Lieutenant Herbert, who pursued the course of the Ganges a considerable way beyond Gangoutri, and " to the place where its head is concealed by masses of snow which never melt."

As we have already made our readers acquainted (see Vol. III. p. 228.) with the interesting observations of Mr Baillie Fraser on the source of the Ganges, we shall proceed to give an abridged abstract of the equally interesting journal of Captain Hodgson.

Having formed little magazines of grain at the places where they intended to halt, and re-established the Sangas or spar-bridges over the river, which had been destroyed by avalanches of snow, the travellers marched from Reital on the 21st May 1817.

" Reital," says Captain Hodgson, " contains about thirty-five houses, and is esteemed a considerable village: as usual in the upper mountains, where timber is plentiful, the houses are large, and two or three storeys high. When a house has three storeys, the lowest serves to shelter the cattle by night, the second is a sort of granary, and in the upper the family dwells. Round it there is generally a strong wooden gallery or balcony, which is supported by beams that project from the walls. The roofs of the houses are made of boards or slates: they are shelving, and project much beyond the top of the walls, and cover the balcony, which is closed, in bad weather, by strong wooden shutters or pannels. These houses are very substantial, and have a handsome appearance at a distance; but they are exceedingly filthy within, and full of vermin. The walls are composed of long cedar beams and stone in alternate courses; the ends of the beams meet all the corners, where they are bolted together by wooden pins. Houses of this construction are said to last for several ages, for the *Deodar* or *Kailou* pine, which I sup-

* Abridged from the *Asiatic Researches*, vol. xiv. p. 60. Calcutta 1822.

pose to be the cedar of *Lebanon*, is the largest, most noble, and durable of all trees.

"The situation of the village on the east side of a mountain, the summit of which is covered with snow, and the foot washed by the *Bhágirat'hí*, is very pleasant. It commands a noble view of the *Srí Cánta*, and other adjoining peaks of the *Himálaya*, on which the snow for ever rests. Snow also remains until the rains, on all the mountains of the second order, which are visible hence both up and down the river. Many cascades are formed by the melting of the snows on the foot of the surrounding mountains. One, in particular, descends in repeated falls of several hundred feet each, from the summit of a mountain across the river, and joins it near *Batheri*."

"*May* 21.—The travellers proceeded from *Reital* to *Tuwarra*; crossed the *Soar* river on a *Sanga* five paces in length; observed some *micaceous* iron-ore on the Salang Mountain. From *Soar* river to above *Tuwarra* the path is exceedingly rugged. The mountains are of granite, with various proportions of quartz and feldspar.

"*May* 22.—Marched in 5 hours and 48 minutes from Tuwarra to Dangal, a very laborious journey. Crossed the *Elgic Gáhr* torrent by a *Sanga* fifteen feet long. On the opposite side of the Ganges observed a range of hot springs, which throw up clouds of steam, and deposit a ferruginous sediment. Crossed the Ganges to *Dangal* by a *Sanga*, made of two stout pine spars, laid from rock to rock.

"*May* 23.—Arrived at *Súci*, from *Dangal*, after a very long and laborious march, in seven hours. Crossed the river by three *Sangas*. Scenery in general grand, and particularly sublime at the falls of *Lahori Naig*, where there is a frightful granite cliff of solid rock above 800 feet high, which has been undermined at its base by the stream. Observed in their route pines of various kinds, and the true deal fir; and, near *Lahori Naig*, a calcareous rill, which encrusts every thing it touches with pure lime: this is singular in a region of granite. *Suci*, a small decaying village, surrounded on all sides by the *Himálaya* rocky precipices, covered with snow.

"*May* 24.—Marched to *Deráli* by a generally excellent mountain path. Crossed the Ganges on a good *Sanga*: crossed

also the *Tíl Ghír*, a large torrent, with a beautiful cascade of 80 or 100 feet over a rock. Crossed also the *Kheir Gádh*, a large rivulet, by a *Sanga* at *Derali*, a small deserted village. The north bases of the mountains on the route were clothed with noble cedars, and various sorts of large pines, generally denominated *Cshir* and *Rhai* or *Rher*. Capt. Hodgson was much delighted with this day's march, the climate being pleasant, the weather bright, and the scenery interesting.

" *May* 25.—Marched to *Bhairog'háti*. Road generally level on the banks of the river; perpendicular rocky precipices rise immediately from the river bed, to the height of 1500 or 2000 feet. After crossing *Licunga*, a small river, on a *Sanga*, came to an exceedingly steep ascent: no vegetation. In front *Decani*, a snowy peak, rising immediately from the bed of the Ganges. Scenery very grand: very large cedars. A sweep from S. to E. brought them to that most terrific and awful place called *Bhairog'háti*. The *Sanga* there was the most formidable they had yet met with. Turned to the left, and pitched their tent at *Bhairog'háti*.

" One of the most curious sights among many here, is to see a little tent pitched under vast overhanging masses of rock, at the confluence of these two rivers, the *Bhagirat'hi* and its foaming rival the *Jáhni Gangá*, or, more properly called, the *Jáhnevi*. The strange and terrific appearance of this place (*Bhairog'háti*) exceeds the idea I had formed of it. No where in my travels in these rude mountains, have I seen any thing to be compared with this in horror and extravagance. Precipices, composed of the most solid granite, confine both rivers in narrow channels, and these seem to have been scooped out by the force of the waters. Near the *Sanga* the *Bhágirat'hi* has in some places scouped out the rock which overhangs it. The base of these peaks is of the most compact sort of granite: it is of a light hue, with some small pieces of black sparry substance intermixed. From the smoothness of the rocks which confine the stream, and which appear to have been worn so by water, I think the stream must have formerly flowed on a higher level, and that it is gradually scooping its channel deeper; for it does not appear that the walls which confine the rivers are masses fallen from above, but that they are the bases of the peaks themselves. Enormous

blocks have indeed fallen, and hang over our heads in threatening confusion; some appear 200 feet in diameter: and here are we sitting among these ruins, by the fireside at noon. What are these pinnacles of rock, 2000 or 3000 feet high, which are above us, like? I know not. To compare small with great, I think the aptest idea I can form of any thing that might be like them, would be the appearance that the ruins of a Gothic cathedral might have to a spectator within them, supposing the thunderbolts or earthquakes had rifted its lofty and massy towers, spires, and buttresses;—the parts left standing might then, in miniature, give an idea of the rocks of *Bhairog'háti.*

"The great cedar pines, those gigantic sons of the snow, fringe these bare rocks, and fix their roots where there appears to be very little soil: a few also of the larger deal pine are seen, but inferior trees do not aspire to grow here. The day is dull and rainy, and I cast my eyes up at the precipice overhead, not without awe;—a single fragment might dash us to pieces. Avalanches of snow and rock, such as we have passed to-day, and indeed for these three last days, shew by their effects their vast powers of destruction, for they bring down forests in their overwhelming course, and dash the cedars into splinters. These avalanches have all fallen this season: they have in places filled up the dells and water-courses to a great depth with snow, and extend from the peaks to the margin of the river.

"A painter wishing to represent a scene of the harshest features of nature, should take his station under the *Sanga* of *Bhairog'háti*, or at the confluence of the *Bhagirat'hi* and *Jáhnevi.* Here it is proper to take some notice of this latter river, hitherto little known. Though the *Bhagirat'hi* is esteemed the *holy and celebrated Ganges*, yet the *Jáhnevi* is accounted to be, and I think is, the larger stream. From a Brahmin who officiates at *Gangotri*, and who has been up it, I collected some particulars, which, though perhaps far from correct, may serve to give an idea of it. By the course of the river is a pass to *Bhoat* or *Thibet*, by which the people from *Reital*, and the upper villages of *Rowairn*, go to get salt, blanket cloth, and wool, in exchange for grain. The trade is trifling, and not more than a hundred people go yearly. In the latter end of the rains the road is open. They carry their goods on sheep and goats.

The Brahmin has been at the frontier village called *Neilang*: it is four long and very difficult days' journey. The first three days are up the course of the river, high above its bed for the most part, but occasionally descending to it. It is exceedingly steep and difficult.

" *May* 26.—Marched to *Gangotri*; climbed rocks, and passed over chasms by means of ladders and scaffolding of decayed planks.

" The path to-day was of the worst description, and is, on the whole, I think, the most rugged march we have hitherto had, though there are not any long ascents. Nothing can be more unpleasant than the passage along the rotten ladders and inclined scaffolds, by which the faces and corners of the precipices near *Bhairog'hati* are made. The rest of the way lies along the side of a very steep mountain, and is strewed with rocks. The views of the snowy peaks, which are on all sides, were very grand and wild.

" The rocks are of granite, but of a lighter colour than usual, and specks of a bright black sparry substance are interspersed in them, at the distances of from one to three inches.

" The river's bed from *Bhairog'háti* to *Gauricund*, was between mural precipices of from 200 to 300 feet high: above them was the steeply inclined ground along which our path lay. Though very rocky, there were many places with soil where the cedars grew, but not large. Above the path to our left were bare rocky precipices, on the summit of which the snow lies. At *Gauricund* and *Gangotri* the river's bed becomes more open. The temple of *Gangotri* has a *mundup* of stone of the smallest kind: it contains small statues of *Bhágirat-hi*, *Gangá*, &c., and it is built over a piece of rock called *Bhágirat'hi-Sila*, and is about twenty feet higher than the bed of the Ganges; and immediately above its right bank, there is also a rough wooden building, at a short distance, for the shelter of travellers. By the river side there is in some places soil, where small cedars grow; but in general the margin is strewed with masses of rock, which fall from the precipices above: the falls do not appear recent. We lay down to rest; but between 10 and 11 o'clock were awakened by the rocking of the ground, and on running out we soon saw the effects of an earthquake, and the

dreadful situation on which we were pitched,* in the midst of masses of rock, some of them more than 100 feet in diameter, and which had fallen from the cliffs above us, probably brought down by some former earthquake.

The scene around us, shewn in all its dangers by the bright moonlight, was indeed very awful. On the second shock, rocks were hurled in every direction, from the peaks around to the bed of the river, with a hideous noise not to be described, and never to be forgotten. After the crash caused by the falls near us had ceased, we could still hear the terrible sounds of heavy falls in the more distant recesses of the mountains.

"We looked up with dismay at the cliffs over head, expecting that the next shock would detach some ruins from them: had they fallen we could not have escaped, as the fragments from the summit would have tumbled over our heads, and we should have been buried by those from the middle.

"Providentially there were no more shocks that night. This earthquake was smartly felt in all parts of the mountains, as well as in the plains of the NW. provinces of Hindustan.

"In the morning we removed to the left bank of the river, where there is a bed of sand of about 150 yards wide; then comes a flat of soil, with trees of about twenty yards wide, and immediately above it are precipices with snow on them. Here we were much more secure: in the afternoon, indeed, the effects of the snow melting often caused pieces of rock to fall from above to near our station; but we could avoid them by running over the sand to the river side, which could not be done on the right bank; besides only comparatively small pieces fell there, and in daylight; so that this is much the best side to encamp on. We had the curiosity to measure trigonometrically the height of the cliff at the foot of which we were during the shock, and found it to be 2745 feet.

"This day (the 27th), as also on the 28th, we had a slight shock of an earthquake.

"The mean breadth of the *Ganges* at *Gangotri* was (measured by the chain) 43 feet, depth 18 inches, and nearly the same depth at the sides as in the middle: the current very swift, and over large rounded stones. This was on the 26th May. The stream was then in one channel, but the effect of

the sun in melting the snow was at that season so powerful, that it was daily much augmented; and, on our return to *Gangotri* on the 2d June, the depth of the main stream was two feet, and it was a few feet wider, but I did not then measure the width; several shallow side channels had also been filled in the interval, and, on the whole, I estimate that the volume of water was doubled.

"Though the frequency of the earthquakes made us very anxious to get out of our dangerous situation in the bed of the river, we resolved, as we had come so far, to leave no means untried to trace the stream as far as possible, and accordingly set out in the morning of the 29th of May, hoping to arrive at the head of the river in the course of the day. The two Gangotri Brahmins could not give us any information respecting its distance; they had never been higher than Gangotri, and assured us that no persons ever went further except the *Múnshi*, who appears, by the account in the *Asiatic Researches*, to have gone about two miles.

"*May* 29.—Proceeded forward up the Ganges, over snow and rocks. The Brahmins never heard of any rock or place called the Cow's Mouth, or *Gao Muc'h*. Pitched on a sort of bank by the left margin of the river.

"This being the only convenient or safe place we could see, we halted here. The river is perceptibly diminished in bulk already, and we hope that to-morrow we may see its head. The march to-day was most toilsome and rough, through the loose fragments of rock which daily fall at this season from the peaks on either side of the river in the afternoon, when the sun melts the snow. Travellers should contrive to gain a safe place by noon, or they may be dashed to pieces. It was very cold at this place, and froze all night; but we had plenty of firewood from the *Bhojpatra* trees. The soil was spungy, and full of rocks. The silence of the night was several times broken by the noise of the falling of distant avalanches.

"By the barometer it appeared we were 11,160 feet above the sea.

"A little tent, which one man carries on his back, came to us; but in this trip we ate and slept on the ground, and were

well pleased to have got so far beyond *Gangotri*, hitherto the boundary of research on the Ganges."

" *May* 30.—Proceeded onwards. Crossed a high avalanche of snow.

" Gradually ascending among rocks. To the left high cliffs of granite, but not so steep as before; to the right snowy peaks, their summits above 600 or 700 feet high, distant about two miles. The river-bed is here about two furlongs wide, and full of stones. River certainly diminished in size: it is very rapid, its bed being an ascent. We are now above the line of vegetation of trees, and past the last firs. The birches remain, but they are only large bushes; laurels are also seen, and a sort of, I believe, *litchen* (*lichen?*) which grows on the rocks. The noble three-peaked mountain shines in our front, and is the grandest and most splendid object the eye of man ever beheld. As no person knows these peaks or their names, we assume the privilege of navigators, and call them St George, St Patrick, and St Andrew. St George bears 129°; St Patrick 132° 30′. On going farther, we saw another lower peak between St George and St Patrick, which we called St David, and the mountain collectively the Four Saints."

" Halted near the *débouche* of the Ganges. This is an excellent and safe place; no peak can fall on us: five companies, or even a battalion, might encamp here. Sublime beyond description is the appearance of the snowy peaks now close to us. The Four Saints are at the head of the valley of snow, and a most magnificent peak, cased in snow and shining ice, stands like a giant to the right of the valley: this we named Mount Moira. The snow valley, which hides the river, appears of great extent.

" We experienced considerable difficulty in breathing, and that peculiar sensation which is always felt at great elevations, where there is any sort of herbage, though I never experienced the like on the naked snow-beds, even when higher. Mountaineers, who know nothing of the thinness of the air, attribute the faintness to the exhalation from noxious plants, and I believe they are right; for a sickening effluvium was given out by them here, as well as on the heights under the snowy peaks,

which I passed over last year above the *Setlej*, though on the highest snow the faintness was not complained of, but only an inability to go far without stopping to take breath.

"We are about 150 feet above the bed of the river. By day the sun is powerful, although we are so surrounded by snow; but the peaks reflect the rays. When the sun sunk behind the mountains, it was very cold: at night it froze. High as we are, the clouds yet rise higher. The colour of the sky is a deep blue. What soil there is, is spungy. A few birch bushes are yet seen; but a large and strong ground-tree or creeper overspreads the ground, somewhat in the manner of furze or brambles; and it is a curious fact, that the wood of this is, we think, that of which the cases of black-lead pencils are made, being of a fine brittle, yet soft red grain; and the smell is the same as of that used for the pencils, and which hitherto has been called by us Cedar. I have specimens of this wood; it is called, I think, *Chandan*: I saw it on the summit of the *Chour* peak, and in the snowy regions of *Kunaur*, but did not then examine it. It will be found probably that the *Pinus Cedrus*, or *Cedar of Lebanon*, is the *Deodar* (or, as it is called to the westward, the *Kailou*), and no other. Nor do our mountain cedars (24 feet in circumference) yield in size or durability to those of Lebanon. But this *Chandan* (miscalled Cedar) is not even a tree: it may be called a large creeper, growing in the manner of bushes, though it is very strong, and some of its arms are as thick as a man's thigh. Of this, and also of the great cedar (*Deodar*), and of other pines, I will send specimens.

"We had brought very few followers upwards from *Gangotri*, but here we sent every one we could possibly dispense with, that our small stock of grain might subsist the remainder, who were a few trusty fellows (Mussulmans), two *Gorc'ha Sipáhis*, and a few *Coolies*, for two days or three, if possible, in the event of our being able to get over the snow in front; and I sent orders to the people at *Gangotri* to leave grain there, if they had any to spare; and if they did not hear of any supply coming from *Reital*, to make the best of their way back till they met it, and then to halt for us, and send some on to us. Having made all the arrangements we could on the important head of supplies, and made observations, we had leisure to admire the very singu-

lar scenery around us, of which it is impossible to give an adequate description.

"The dazzling brilliancy of the snow was rendered more striking by its contrast with the dark blue colour of the sky, which is caused by the thinness of the air, and at night the stars shone with a lustre which they have not in a denser atmosphere: it was curious, too, to see them, when rising, appear like one sudden flash, as they emerged from behind the bright snowy summits close to us, and their disappearance, when setting behind the peaks, was as sudden as we generally observed it to be in their occultations by the moon.

"We were surrounded by gigantic peaks, entirely cased in snow, and almost beyond the regions of animal and vegetable life, and an awful silence prevailed, except when broken by the thundering peals of falling avalanches. Nothing met our eyes resembling the scenery in the haunts of men: by moonlight all appeared cold, wild, and stupendous, and a Pagan might aptly imagine the place a fit abode for demons. We did not even see bears, or musk deer, or eagles, or any living creature, except some small birds.

"To form an idea of the imposing appearance of a snowy peak, as seen here, under an angle of elevation of nearly 33°, and when its distance is not quite three miles, and yet its height is 8052 feet above the station, one should reflect, that if, even viewed from the plains of Hindustan, at angles of elevation of 1° and $1\frac{1}{2}$°, these peaks, towering over many intermediate ranges of mountains, inspire the mind with ideas of their grandeur, even at so great a distance; how much more must they do so, when their whole bulk, cased in snow from the base to the summit, at once fills the eye. It falls to the lot of few to contemplate so magnificent an object as a snow-clad peak, rising to the height of upwards of a mile and a half, at the short horizontal distance of only two miles and three quarters.

"*May* 31.—Advanced from last halting-place, and reached a most wonderful scene, which is thus described by Captain Hodgson.

"The *Bhagirat'hi* or *Ganges* issues from under a very low arch at the foot of the grand snow bed. The river is here bounded to the right and left by high snow and rocks; but in

front, over the *débouché*, the mass of snow is perfectly perpendicular; and from the bed of the stream to the summit, we estimate the thickness at little less than 300 feet of solid frozen snow, probably the accumulation of ages. It is in layers of some feet thick, each seemingly the remains of a fall of a separate year. From the brow of this curious wall of snow, and immediately above the outlet of the stream, large and hoary icicles depend: they are formed by the freezing of the melted snow-water of the top of the bed, for in the middle of the day the sun is powerful, and the water produced by its action falls over this place in cascade, but is frozen at night. The Gangotri Brahmin who came with us, and who is only an illiterate mountaineer, observed, that he thought these icicles must be *Mahádéva's Hair*, from whence, as he understood, it is written in the *Shástra*, the Ganges flows. I mention this, thinking it a good idea: but the man had never heard of such a place actually existing, nor had he or any other person, to his knowledge, even been here. In modern times they may not, but *Hindus* of research may formerly have been here; and if so, I cannot think of any place to which they might more aptly give the name of a Cow's Mouth, than to this extraordinary *débouché*. The height of the arch of snow is only sufficient to let a stream flow under it. Blocks of snow were falling about us, so there was little time to do more here than to measure the size of the stream. Measured by a chain, the mean breadth was 27 feet; the greatest depth at that place being knee deep, or 18 inches, but more generally a foot deep, and rather less just at the edges, say 9 or 10 inches; however, call the mean depth 15 inches. Believing this to be (as I have every reason to suppose it is) the first appearance of the famous and true Ganges in daylight, we saluted her with a bugle-march, and proceeded (having to turn a little back to gain an oblique path) to the top of the snow-bed, having ascended it to the left.

"Ascent of the same kind, general acclivity 7°, but we pass over small hollows in the snow, caused by its irregular subsiding. A very dangerous place: the snow stuck full of rubbish, and rocks imbedded in it. Many rents in the snow appear to have been recently made; their sides shrinking and fall-

ing in. A man sank into the snow, and was got out, not without some delay. The bed of the Ganges is to the right, but quite concealed by the snow.

"In high hope of getting on to what may be at the top of the acclivity, we have come on cheerily over the hollow and treacherous compound of snow and rubbish; but now, with bitter regret, we both agree that to go on is impossible. The sun is melting the snow on all sides, and its surface will not bear us any longer. I have sunk up to my neck, as well as others. The surface is more and more ragged, and broken into chasms, rifts, and ravines of snow, with steep sides. Ponds of water form in the bottoms of these, and the large and deep pools at the bottoms of the snow hollows, and which were in the earlier part of the day frozen, are now liquid. It is evident, from the falling in of the sides of the rents in the snow, that there are hollows below, and that we stand on a treacherous foundation It is one o'clock, and the scene full of anxiety and awe. The avalanches fall from Mount Moira with the noise of thunder, and we fear our unsteady support may be shaken by the shocks, and that we may sink with it.

"Had it been possible to have got across the chasms in the snow, we should have made every exertion, so anxious were we to get forward; but onward, their sides were so steep, and they appeared of such great depth, that I do not think it would be possible to pass them (this year at least); even if the snow were not, as at this hour, soft, and the bottoms of the chasms filling with water. Be that as it may, they are now utterly impassable. At this season snow must fall here whenever it rains below; so that it does not acquire such hardness at the top, as it does on the avalanches we have hitherto passed, where no new snow at present falls. We now set out on our return, and not too soon, as we found, for the snow was so soft, and the increase of the water so great, that though we went with the utmost possible expedition, it was only by two hours and a half hard labour of wading and floundering in the snow, and scrambling among rocks, where they would give a footing, that we reached the turf, tired and bruised with falls, and the skin taken off from our faces and hands, by the sun and drying wind of these elevated regions."

"It now remains to give some account of this bed or valley of snow, which gives rises to the Ganges. It appears that we passed up it, somewhat more than a mile and a half.—From our last station, we could see onwards, as we estimated, about five miles, to where there seemed to be a crest or ridge of considerable elevation, though low when compared with the great peak which flanked it. The general slope of the surface of the snow valley was 7°, which was the angle of elevation of the crest, while that of the peak St George, one of those which flanked it to the left, was 17° 49′. In the space we had passed over the snow bed, the Ganges was not to be seen; it was concealed, probably, many hundred feet below the surface. We had a fair view onward, and there was no sign of the river; and I am firmly convinced that its first appearance in day is at the *débouché* I have described. Perhaps, indeed, some of those various chasms and rents in the snow-bed, which intersect it in all sorts of irregular directions, may occasionally let in the light on some part of the bed of the stream; but the general line and direction of it could only be guessed at, as it is altogether here far below the broken snowy surface. The breadth of the snow valley or bed is about a mile and a half, and its length may be $6\frac{1}{2}$ or 7 miles from the *débouché* of the river to the summit of the slope, which terminated our view; as to the depth of the snow, it is impossible to form a correct judgment, but it must be very great. It may easily be imagined, that a large supply of water is furnished at this season, by the melting of this vast mass in the valley, as well as by the melting of that of the great peaks which bound it. From their bases torrents rush, which, cutting their way under snow, tend to the centre of the valley, and form the young Ganges, which is further augmented by the waters which filter through the rents of the snow-bed itself. In this manner, all the Himalaya rivers, whose heads I have visited, and passed over, are formed; they all issue in a full stream from under thick beds of snow, and differ from the Ganges, inasmuch as their streams are less, and so are their parent snows. On our return down the snow valley, we passed nearer to its north side than in going up, and saw a very considerable torrent cutting under it from the peak; this was making its way to the centre. At times, we saw it through rents in the snow, and at others,

only heard its noise. As there must be several more such feeders, they will be fully sufficient to form such a stream as we observed the Ganges to be at the *débouché*, in the space of six or seven miles. I am fully satisfied, that, if we could have gone further, that we should not have again seen the river, and that its appearance at *Mahádéva's* Hair, was the real and first *débouché* of the *B'hágirathá*. All I regret is, that we could not go to the ridge, to see what was beyond it. I suspect there must be a descent, but over long and impassable wastes of snow, and not in such a direction as would lead direct to any plains, as the course to bring one to such plains would be to the N.E. or N., whereas the line of the river's course, or rather of the ridge in front, was to the S.E., parallel to the run of the Himalaya, which is generally from S.E. to N.W. Immediately in front of the ridge no peaks were seen, but on its S.E. flank, and at the distance of about 18 miles, a large snowy peak appeared; so that I think there can be no plain within a considerable distance of the S.E. side of the ridge: if there be streams from its other side, they must flow to the S.E. After all, I do not know how we should have existed, if we had been able to go to the ridge, for we could not have arrived there before night, and to pass the night on these extensive snows, without firewood or shelter, would have cost some of us our lives; but of that we did not then consider much. We had only a few trusty men with us, and a short allowance of grain for them, for this and the following day, and had sent orders to the people left at Gangotri, to make their way back towards Reital, leaving us what grain could be spared, and to forward on what they might meet, as I expected some from Reital, from whence we were supplied during our absence from it, of altogether 28 days. I cannot suppose, that by this way there can be any practicable or useful pass to the Tartarian districts, or doubtless the people would have found it out, and used it, as they do that up the course of the *Jáhnaví*."

" No volcanoes were seen or heard of in these mountains, whose composition is granite of various kinds and colours. No shells or animal remains were seen. The magnetic variation was small, and differing little, if at all, from what it is on the plains of the Upper Provinces; it is from 40′ to 1° and 2°, according to different needles, and is easterly, by which I mean, that the

variation must be added to the magnetic azimuth. The diurnal small changes in the barometer were perceptible, the mercury always falling a little before noon, as in the plains."

"It was remarked above, that the snow on the great bed was stuck as it were with rock and rubbish in such a manner, as that the stones and large pieces of rock are supported in the snow, and sink as it sinks. As they are at such a distance from the peaks, as to preclude the idea that they could have rolled down to their parent places, except their sharp points had been covered, it appears most likely, that the very weighty falls of snow, which there must be here, in the winter, bring down with them pieces of rock, in the same manner as a large snow ball would collect gravel, and carry it on with it in its course. Masses of snow, falling from the high peaks which bound the snow bed, if they chanced to collect more, and to take a rounded form, would have a prodigious impulse, and might roll to the centre of the snow valley, loaded with the pieces of rock they had involved.

"It is not very easy to account for the deep rents which intersect this snow-bed, without supposing it to be full of hollow places. It struck us, that the late earthquakes might have occasioned some of the rents. I never saw them before on other snow-beds, except at Jumnotri, where they are occasioned by the steam of the extensive range of boiling springs there: perhaps there may be such springs here also. They are frequent in the Himalaya, and one might suppose they were a provision of Nature to insure a supply of water to the heads of the great rivers in the winter, when the sun can have little power of melting the snow above those deep recesses."

Art. IV.—*Historical Account of Discoveries respecting the Double Refraction and the Polarisation of Light.* (Continued from p. 160. of this volume.)

Sect. III.—Continued. *Account of the Experiments of* Mr Benjamin Martin.

The Second Essay of Mr Benjamin Martin is entitled, "*Essay* II. *On the Nature and Wonderful Properties of Island Crystal*, containing, 1. The Construction of a Telescope

with an Object Glass of Island Crystal, and a double Focus. 2. The construction of a Microscope with a Magnifying Lens of Island Crystal, and a Double Focus. 3. The strange and singular property of a Prism of Island Crystal, which refracts Rays of Light both from and towards the Perpendicular, contrary to all others. 4 An account of a Prism of Island Crystal, that refracts a beam into twenty different rays of coloured light, or exhibits twenty coloured images of one object."

"*Preface.*—It seems to me that men of the greatest mental powers have a limit prescribed to the exertion of them; else how can we account for Hugenius's and Sir Isaac Newton's silence concerning the optical forms and uses of Island Crystal? They were not only the greatest mathematicians, but the very greatest opticians that any age has produced; and that not only in theory but in practice: The former had a large apparatus for grinding all kinds of glasses; and the latter did not think it beneath him to employ himself in grinding prisms, lenses and mirrors. But not a word in either of these authors about prisms or lenses of Island Crystal; or of its multuple and colorific refraction. Sir Isaac mentions the Polishing Island Crystal indeed, but in a manner as plainly shews it could be of no use, and it does not appear that he ever tried any experiments with a polished piece in the solar rays, or common light; for if he had, he could not have missed a discovery of most of its amazing properties, which make the subject of the present essays; and which would have put him upon a further inquiry into the nature of light, and the powers of bodies to refract it; all which must now be referred to the age which another Newton shall adorn!

"In the first part of this Tract I have given an account of several new properties of Island Crystal, and of the various modifications and refractions of the rays of light through its substance, very different from those which we observe in glass, or any other diaphanous subjects hitherto used in optics. To these I shall now add some other discoveries which I have since made in this wonderful spar, not only in regard to *prisms*, but

object-lenses of telescopes and microscopes, which I have long since constructed therewith.

"In a brass tool, whose radius is 4.4 inches, I caused to be ground several very clear pieces of this crystal, and they made good lenses for *Galilean telescopes*, as they were hard enough to admit of a very true figure and polish. In the same tool a piece of *plate-glass* was also ground. Note, these lenses were all of them *plano-convexes*.

"The solar-focal distances of the glass and crystal lenses were determined by measuring them accurately in the sun-beams, as follows; AB (Plate V. Fig. 1.) the glass lens converged the parallel rays DA, EC to a focus at F at the distance CF=8.4 inches. Suppose N the center of the tool, or convexity of the lens, and draw NAG, then the angle of the incident ray AD will be DAN=ANC, and of the refracted ray AF it will be GAF; and therefore it will be as AF : FN :: sine of incidence : sine of refraction :: 8.4 : 12.8 :: 3 : 4.56 :: 1 : 1.52.

"The plano-convex AB of *Island Crystal* (Fig. 2.) being held in the sun's ray refracted them to two different *focuses*, viz. F and *f*. The focal distance of the *least refracted rays* was CF = $7\frac{1}{2}$ inches. Therefore the sine of incidence : sine of refraction :: AF : FN :: $7\frac{1}{2}$: 11.9 :: 3 : 4.76 :: 1 : 1.586.

"The pencil of the *most refracted rays* terminated at *f*, at the focal distance C*f*=6.1 inches. Therefore the sine of incidence : sine of refraction :: A*f*: N*f*:: 6.1 : 10.5 :: 3 : 5.16 :: 1 : 1.72. Sir Isaac Newton makes this ratio as 3 : 5, as we formerly observed.

"Having determined the two focal distances CF and C*f* in one lens, they are known for any other of a given radius of convexity, they being always proportional to the radii of the said lenses. For example, in a lens (plano-convex) ground in a tool whose radius is 0.55 of an inch, the focal distances are 0.94 and 0.76: because radius 4.4 : radius 0.55 :: 7.5 : 0.94, and :: 6.1 : 0.76

"As the lens AB in the present opera has two focuses at the distance F*f*=1.4 inch, it will require two marks or circles upon the inmost tube or drawer to which it must be drawn out and in, to adjust it to each focus respectively.

"The images of objects formed in those focuses F and *f* will be in proportion to their focal distances CF and C*f*, and that image in the focus F, as it is largest, is also rather the most perfect of the two; and I do not find but that one of these refractions is as much stated and constant by the lens as the other

"The images being at so great a distance, viz. near 1½ inch apart, when one is seen distinctly, then only a skim or nebulous appearance of the other can be observed; so that one image does not interfere with or spoil the view of the other.

"If you draw out the slider to about the middle distance between the two marks upon it, then both the images will appear imperfectly; and, in this case, you will observe the images at *f* projected on one side the image F, viz. at *g*, in the plane of the Field of View; and by holding the drawer very fast and in one position, if you turn the case round which holds the lens, you will observe the first image at *g*, to move in a circular manner about the image at F, which will appear at rest. And it is further to be observed, that, in this motion, the position of the image *g* is constantly the same, or parallel to itself in every part of its circuit.

"A concave eye-glass of 2, or 2½ inches focus will do best, as it gives a large field of view, the principal thing here to be regarded, and will magnify as much as a common opera, viz. 3 or 3½ times. Such is the construction of a telescope of *Island* Crystal best suited, as I judge, for the Amusement of the *virtuoso* in this kind of *phænomena.*

"A *microscope* constructed in the same manner with a small object lens of Island Crystal is seen in Fig. 3. where AB is the object lens whose radius of convexity is 0.55 of an inch, and its two solar focuses at the distance of 0.94 and 0.76 of an inch, as above specified, being a *plano-convex.*

"In my *Island Crystal* Microscope, the distance between the object lens AB and the eye-glass GH, is 6 inches, and the focal distance of the glass GH one inch; therefore, by adjusting the microscope to the small object DE, there will be two images formed successively at the focus F of the eye-glass, at the distance CF = 5 inches.

"The lens AB to form the image at F by the least refracted rays, must be at the distance CE = 1.113 inch from the object

ED; but at that distance the image by the most refracted rays will be formed at f, at the distance $Cf = 2.44$ inches, hence the distance between the two images at f and F will be $Ff = 2.56$ inches.

"Therefore, in order to view the image made by the greatest refraction, the lens AB must be placed lower at *ab*, to make the image f rise to F, the focus of the eye-glass GH. The distance Aa is about $\frac{1}{5}$ of an inch.

"The button or cell, holding the lens AB, has a *horizontal* motion, and, by turning it round, the two images will be seen to circulate round a common center, and also one about the other, yet so that they always keep parallel each one to itself, and both to one another.

"I shall only add, that I find, by experience, the best method of making those experiments is by making one fine hole (or more) with a pin in a black spot of a card, (a *club* or *spade*,) and laying it under the lens, you reflect a strong light through it; which illumined hole makes two excellent images for this purpose.

"After the same manner you may make five small holes in a right line, in the compass of $\frac{1}{10}$th of an inch; these five holes well illuminated will afford ten images, which will appear in *two rows* near together; then, upon turning the cell round, you will observe all the ten images in motion in a very curious manner, one rank moving up, then turning round the other, after this they traverse between, and go down; and thus keep mutually and regularly moving among each other, they in some measure make a *microscope dance* of images to the no small divertisement of the Tyro in Optics.

"Thus much for the construction of a telescope and microscope with Island crystal. We now return once more to speculate the wonderful properties of this substance formed into prisms, that have not yet been mentioned, or ever before observed. It has been hitherto allowed that a ray of light passing out of a dense solid medium into one that is rarer, *will always be refracted from the perpendicular in that point;* and this law of Nature was never found to have any exception in all common refracting crystals, Glass, &c. nor even in *Island* crystal, till since I published my *first essay* upon it.

"For though I had there shewn that if a beam of light AB (Fig. 4.) were let into a dark room through a hole in the window-shut at A, and were to fall perpendicular upon the side ED of a parallelopiped DF of Island crystal, it would pass directly through it to the opposite side at C, and there, in many pieces of crystal, it will be divided into three parts, viz. CK, CH, CI; of which the first being unrefracted will shew an image of the hole A without colours; but the other two parts CH, CI, are refracted on each side from the perpendicular CK, and therefore make two coloured images of the hole at H and I.

"Even in those rare pieces (of the same form) that separate the beam AB into twelve parts, each part is uniformly refracted from the perpendicular ray in the middle on every side, as I there observed. And the same thing was thought to be the case in all refractions through *prisms*, let the number of parts into which the beam was divided, be less or more.

"But a lump of this spar or crystal (from the *Peak* in *Derbyshire*), has lately convinced me that we are not yet capable of discerning the limits or laws of the refracting powers of bodies; because in many prisms made from this large piece of Island crystal, it is proved to be fact, *that the same beam of light passing through the prism will in part be refracted* from *the perpendicular, and in part refracted* towards it.

"As this is so novel and singular a case, I shall illustrate it by Fig. 5., where AB is a beam of light from the hole A in the shutter, and incident upon the prism DEF in the point B, from whence it is refracted to C in the other side; and there it will suffer a strange kind of refraction into different sorts of rays as follows, viz. (1.) There will be two parcels of rays CG and CH, refracted from the perpendicular CP, and each of them gives a coloured image of the hole at G and H. (2.) Another part of the beam is much more refracted from C to I, and there exhibits an image of the hole A, in much stronger and more vivid colours. (3.) But there is yet a small part of the original beam AB remaining, and which is refracted (contrary to the others) into the rays CK towards the perpendicular CP, and makes an image at K much less luminous than any of the other, yet has all the different sorts of colour as they have; but (4.) The colours of this last image at K are quite in an inverse order to the

colours of the other three at G, H, I; for in them (as in common prisms), the red rays are next the perpendicular, but in the rays CK they are farthest from it.

" From the phenomena of this experiment, we are assured of a peculiar property and idiomatic difference in the constitution and nature of this species of *Island crystal.* For here we discover a power residing in every part of this substance, that acts upon the particles of light in *two different and directly contrary modes*, a thing perhaps never observed in the operations of nature before. The same needle will be made to move in two different and contrary directions by magnetism, but then this magnetic power is found to *reside in two different parts* of the magnet. There are also experiments to shew, that light bodies will be moved in contrary directions by the action of electrical fluids; but these fluids possess not the same body, for one is found in *glass*, the other in *amber.* But, in the case before us, if we say the refraction of the rays CG is occasioned by *attraction* in the prism, we may, with equal propriety, say, the refraction of the ray CK is produced by *repulsion*, or that there is a *power of a positive and negative* nature residing in the same, and every point of the prism, which is a matter very difficult to conceive.

" The position of the prism in the Figure is such as makes the rays CG, GH, CI, CK, all *stationary*, that is, when the rays BC go through it parallel to the base DE; and then all those refracted rays are as near to one another as they can be; but upon moving the prism ever so little out of that position, you will observe a very quick motion in the two extreme rays CI, CK, towards contrary parts to *i* and *k*, while the two mean rays CG, CH, move very slowly to *g* and *h*.

" And it is further to be observed, that the ray CK is not only refracted in a direction (contrary to the rest) *towards* the perpendicular CP, but even so far that the image of an object shall appear considerably below the direction of the incident ray. Thus, let C*m* be parallel to AB, then will the ray C be refracted below it to C*l*; and, therefore, if you view the flame of a candle through the prism (posited as in the Figure), you may make the image of the flame appear either below the candle seen from K, or to coincide with it as viewed in the direction

C*m*, or to rise above it if viewed in the line C *l*, a phenomenon never seen or heard of in a prism before.

"It matters not in what part of the prism the beam AB is incident; for the effect will always be invariably the same. Nor does it signify whether the prism be large or small, foul or clear, if you can but see the light through it, the refraction thereof will ever be the same, as I have found by experiments with many of them made from the same piece of spar.

"There is yet another property in this same piece of crystal equally strange and astonishing, viz. That if it be formed into a prism another way, it will discover a twenty-fold power of refraction, or it will refract a beam of the solar light into twenty different rays; and of course it will exhibit twenty different images of one object only, as the sun, a candle, &c.

"As these are such singular phenomena, I shall give the method of forming the prisms to exhibit them, as represented in Fig. 6., where AE is a piece of crystal of the usual rhomboid form. It is easy to see, that every such rhombus consists of, and may be resolved into, two equal prisms, viz. ABDCEH and EFGHAC; or, upon the other side of the obtuse angle C, you have the two prisms CDEFHB and ABHGFC.

"In the first case, if the second prism be ground away, it will leave the first prism ABCDEH, which, when polished, will exhibit the last-mentioned phenomena of the prism DEF in Fig. 5. of four images.

"But, in the second case, if the prism AGHBCF be ground off, there will remain the prism CDEFHB, that, when polished, will produce the twenty rays or images above mentioned. Such wonderful and different effects are occasioned by the same forms given to the same piece of Island crystal on its different parts.

"This system of images appears in the form of a *rhomboides* ABCD as represented in Fig. 7. with five rows of images, of four in a row, and all parallel to one another. It is with some difficulty that the two images of a candle in the acute angles B and D can be seen; but by use, and a dextrous management of the prisms, they may all be seen.

"If in so short a time a *multiple refraction* from two to twenty times has been discovered, who can pretend to guess at the

extent or bounds of this wonderful refracting power of Island crystal? Or by what method can we proceed to account for it? I once had a notion, that a number of fissures, discernible in some pieces, might be concerned in the cause of it; but I am thoroughly satisfied now they are not. Sir Isaac Newton accounts for *reflexion and refraction of light* by the action or power of an *undulating fluid*, or subtle spirit, near the surface of polished bodies; and since it is more than probable that all the parts of natural bodies are kept in perpetual motion by the action of the same subtle spirit or fluid, why may we not, by a parity of reason, say that the different and multuple refractions in Island crystal, may be occasioned by the undulations within the surface, as well as without it? If *fits of easy refraction and easy reflexion of the rays*, within their substance, under various modifications, will not be allowed, a more plausible reason ought to be assigned by those who can think on one that is so; it is enough for me that I can prove the facts, and verify every thing here advanced, however strange and astonishing, by a variety of easy experiments.

"With respect to the figure of the several pieces of Island crystal, it is not to be supposed they are all of that regular form of an *oblique parallelopiped*, as represented in Fig. 1 of the Plate of the first Essay, though the generality of them are such. For this crystal spar, like many others, shoots out from a large base on the rock, into many irregular, uneven-sided scalenous *pyramids*, small and large; which, when broken by gentle strokes with a hammer, readily split and slifter into many pieces, parallel-wise to the base; and such as come out of the middle parts are of the figure above mentioned; but those on the outside are of irregular forms, with opposite sides and angles unequal. Some are like a *wedge* or *isosceles prisms*, some *quadrangular pyramids*, &c.

"Again, some of these spars are very hard, and will take a fine polish; others are softer, and though you may give them a polish, they will soon lose it. Some of these pieces are colourless and transparent as glass itself, though few of these are to be met with, as the greatest part is foul with *mundic*, and other opacious matter. Some pieces are of a yellowish hue, and others of a darker complexion; all agree in having a *double re-*

fraction and a *double focus*, when ground into lenses; but they differ in other respects, according to their different species.

"Before I quit the subject, it may be proper to observe, that the original particles of *Iceland crystal* derive all their wonderful powers and properties of acting upon, and variously refracting the rays of light, from a peculiar disposition and construction in their *concrete, compact, and solid state;* because those very particles, when reduced to a fluid state, discover no such powers or action on light; they do not so much as cause a *double refraction;* they only co-operate with the particles of the dissolvent medium in producing a *single refraction* of light, but the colours are thereby greatly heightened and strengthened; as will appear by dissolving ¼ of an ounce of the crystal in ¾ths of an ounce of *aquafortis*, and putting the solution (when clear) into an hollow glass-prism, and then measuring the refraction, in the same manner as for water, and other fluids.

"One would think if these strange powers were inherent in the particles of the crystal, they would produce these effects in every *transparent state*, whether *solid or fluid;* and, if you suppose the cause to be in the particles of light, then why should they not suffer the same refractions in their passage through them in a *fluid*, as well as in a *solid state?* If the cause be not in the matter of the crystal, and of light, it must be owing to some special modification of the crystalline particles, in their solid or consistent state, which subjects them to the peculiar agency of a *spiritus subtillissimus*, as above mentioned.

"Though all the phenomena of Island crystal may be easily experimented with the *flame of a candle*, or small *bright image* of a window made by reflection from the surface of a *convex speculum*, or from the sun itself viewed through the crystal, with a dark glass before the eye; yet the most perfect and genuine way, is by placing the prisms and parallelopipeds in the rays of the sun in the dark room; and then the actual separation of the rays, and all the variety of colours in each, will most beautifully appear to the eye, as they pass across the room, and form the numerous images of the sun on the opposite wall, or on the ceiling.

"The method I take for this purpose is the following: I have a box or case about 6 inches long, ¾ths wide and deep, with

a lid that slides on and off. This box is divided into *six cells*, in these I put prisms and parallelopipeds of glass, and Iceland crystal, with proper holes on each side for light to pass through them. Then a box-holder being made of springy thin b ass, with a motion every way, is screwed on to the apparatus of a solar microscope, in the room or place of Wilson's microscope; and the long box being put into the holder, and the looking-glass adjusted to reflect the sun-beams horizontally, they will pass through the glass or crystal that is placed in them successively; and all the variety of refractions, and their coloured images, will appear, under all the advantageous circumstances, by the motion of the box, so as to produce the most delectable entertainment to a curious mind.

" And here I cannot help making a few reflections on the unequal, or rather iniquitous estimation of things in general. What a value do we often set upon that which has no real worth at all? Wherein does the preciousness of most precious stones consist? And who can account for the princely esteem of an oyster shell pearl?

" Something, indeed, may be alleged in favour of the most extravagant valuation of a diamond; but what is it? why, only this, that it exceeds all other bodies in *transparency*, *brilliancy*, and *hardness*; yet all this amounts to nothing more than a superiority of the *common qualities* of natural bodies: it has no new, singular, or peculiar property of its own: It may make a man more splendid, but cannot make him wiser, at least by wearing it in his hat, or a diadem. On the other hand, how notoriously are things of the greatest value overlooked, neglected, or disesteemed! Amongst a hundred other curious subjects, let *Iceland crystal* prove this truth,—a body of a most singular nature and endowment, yet little known or inquired after,—a subject without a compeer in nature; for though amber *, borax, pebble, &c. are found to have a double refraction, it is in no sensible or significant degree.—No substance but Island crystal has a *multuple* and *multifarious* refraction of light, even to an unknown degree.—No crystal but this, with *parallel sides*, produces any colorific refraction of the solar rays.—No pellucid

* By *Amber* the author must mean *Mellite*, as the separation of the rays cannot be seen in Amber.—Ed.

body but Island crystal refracts a ray of light, both *from* and *towards* the perpendicular, in the same medium.—With Iceland crystal only, can you construct a microscope or telescope, with a double focus.—'Tis by Iceland crystal we are taught how little we know of the nature of light, and the mutual action between it and common matter.—'Tis by Iceland crystal we learn how much remains to complete a competent theory of optics; and how small a portion of that curious science depends upon the laws of refraction in glass.—In short, by means of Iceland crystal, it seems very probable, that posterity will have laid open to them a much more extensive and perfect view of the field of Nature, than we, with all our boasted improvements, at present enjoy. And whatever others may think of this substance, I esteem it the greatest curiosity of Nature, and pregnant with future systems of philosophical science. And, if my leisure hours, amusements, and experiments on this important subject, may be an excitement to others for further researches therein, I shall have all the honour and satisfaction that any author can wish for, as a reward for his trouble *."

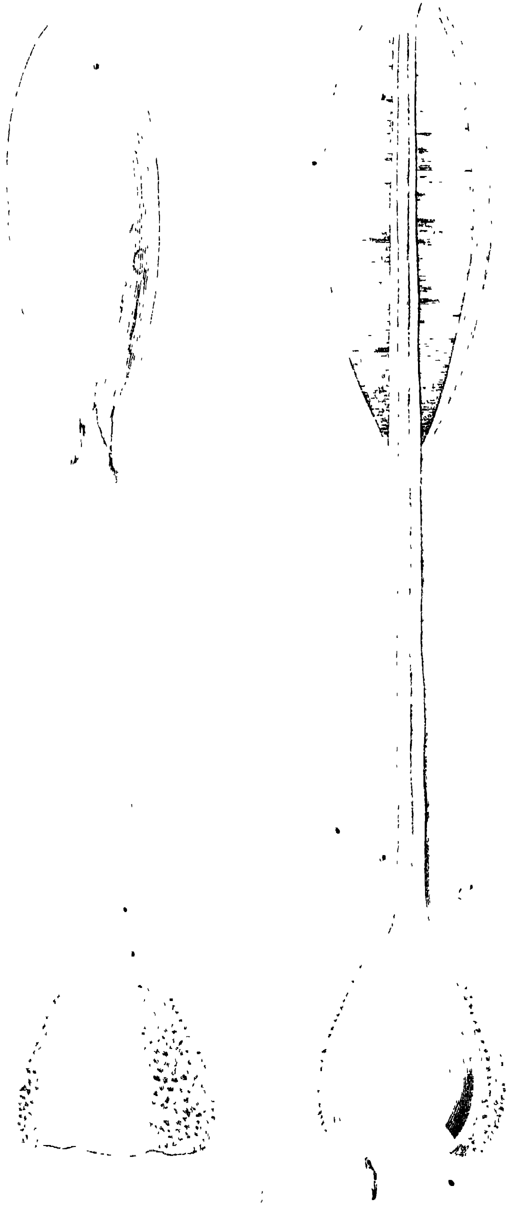
Art. V.—*Observations on a New Genus of Plants, belonging to the Natural Order Gastromyci.* By Robert Kaye Greville, Esq. F. R. S. E. & M. W. S., &c.

Professor Link has, in the third volume of the Memoirs of the Society of Friends of Natural History of Berlin, distributed the *fungi* into four natural orders, retaining as true Fungi a comparatively small number of genera. In that highly meritorious essay, the celebrated Professor has done more towards a rational arrangement of the obscure plants of this difficult department of botany than perhaps any other author.

His third natural Order, Gastromyci, is composed of those fungoid plants which have their sporules contained within one or more coverings; a principal section of which order, is formed of those genera whose sporules are intermixed with a mass of fila-

* We have been indebted for the originals of these two scarce essays to Mr William Jones, optician, London.—Ed.

PALTE VI.



ments It is here that the plants range, of which I am about to speak.

Persoon, in his *Synopsis Fungorum*, has thrown together, under the genus *Scleroderma*, several very anomalous species, especially the three first. *Sclerod. pistillare*, he probably had no opportunity of dissecting, or he must have perceived its peculiar structure. I have recently, however, had the satisfaction of examining this curious plant, through the liberality of my friend Dr Grahame, Professor of Botany in the University of Edinburgh, to whom specimens were communicated by Mr White of Madras. The very remarkable character of the stem passing through the peridium to its very summit, suffices at once to remove it from *Scleroderma*; but another equally striking peculiarity is the dehiscence at the base of the peridium, a circumstance which Persoon himself notices, as belonging to his *Sclerod. carcinomale* This species also, I have no doubt, ought to be separated along with *Sclerod. pistillare*, as it has the same general form, and a cylindrical stem, added to the peculiar dehiscence. Persoon does not appear to have seen it, and from the loose and brief manner in which he has noticed it, a doubt even exists whether it may not prove the same as the other, an idea the localities rather tend to confirm. I have, however, never seen the latter species, and can only judge of its affinity from Persoon's description. In the disposition of the filaments within the peridium, *Sclerod. pistillare* differs materially from the rest of the genus They arise from the percurrent stem, and pass in a straight horizontal line to the outer wall or peridium, to which, however, they are scarcely attached; among these filaments the sporules are profusely scattered. Perhaps by "*fibris rectis*" Persoon intends to express the same character in *Sclerod. carcinomale*

Of these two plants, therefore, so remarkable in their external form, and more so in their internal structure, I propose to constitute a distinct genus, which I shall name Schweinitzia, in honour of the excellent mycologist Schweiniz, one of the authors of the *Conspectus Fungorum in Lusatia superioris Agro Niskiensi crescentium*

SCHWEINITZIA.

GEN. CHAR.—*Peridium stipitatum, ad basin dehiscens. Stipes percurrens.*

1. *S. pistillaris*, clavata; peridium oblongum; stipite torto valido, basi bulboso tomentoso. *Tab.*

 SCLERODERMA pistillare. *Pers. Syn. Fung.* p. 150.

 LYCOPERDON pistillare. *Linn. Syst. Veg.* ed. 15. p. 1019.

 HAB. In India Orientali; ad terram.

 DESC. Tota planta straminea, demum rufescens, spithamæa. *Peridium* simplex? oblongum, stipite quadruplo crassius, membranâ scariosâ vestitum, ad basin irregulariter ruptum; intus, sporulis ferruginiis et filamentis rectis horizontalibus repletum. *Stipes* percurrens et peridii summitati adnatus, elongatus, cylindricus, tortus, validus, suberosus vel sublignosus, basi bulbosus, tomentosus.

2. *S. carcinomalis*, "clavata, stipite cylindrico: fibris rectis." *Pers.*

 SCLERODERMA carcinomale, *Pers. Syn. Fung.* p. 151.

 LYCOPERDON carcinomale, *Linn. Supl. Pl.* p. 453. *Thunb. Diss. Acad.* v. i. p. 274. (fide Pers.)

 HAB. Ad Caput Bonæ Spei in acervis formicarum.

Pulvis et tomentum fusca. (Ex Pers. l. c. p. 152.) An species distincta*?

Explanation of Plate VI.

Fig. 1. A plant of the natural size.
 2. A longitudinal section of the same.
 3. Filaments and sporules, highly magnified.

EDINBURGH,
Dec. 20. 1822.

* *Scleroderma herculaneum* of Persoon (Lycoperdon herculaneum of Pallas), from the description, agrees in some points with our genus *Schweinitzia*; but differs in others. From Scleroderma it is undoubtedly distinct, and will probably form another genus.

ART. VI.—*Miscellaneous Notices in Natural History, by* Professor BLUMENBACH, *viz.* 1. *Account of the Snow Ophthalmia, with the Methods employed in preventing it;* 2. *Remarkable Irritability of the Tongue;* 3. *The Xanthoöpia of Jaundiced Persons;* 4. *On the Prickle of the Extremity of the Tail of the Lion;* 5. *Domestic Sheep again become wild;* 6. *The Genuine Opsian Stone.*

1. *Account of the Snow Ophthalmia, with the methods employed for preventing it.*

XENOPHON, in his account of the expedition of the younger Cyrus, relates, that when the Grecian army was crossing the snowy mountains of Armenia, between the Euphrates and Phasis, in the middle of winter (which answers to the beginning of January according to our present mode of dividing time), many of the soldiers were blinded by the insupportable brightness of the snow; and that, with the intention of preventing or curing this annoying affection, they bound something black (μελαν τι) before their eyes *.

It appears that this snow ophthalmia, of which we sometimes see examples even among ourselves, in the winter season, is endemic in alpine and northern countries; so that the Laplanders, when returning from the chase of the wild rein-deer, are for some days almost entirely destitute of sight †. The Greenlanders are affected with this disease of the eyes chiefly in the months of May and June, and if it continue longer, they attempt its cure by making an incision in the skin of the upper eyelid ‡. The Esquimaux labour under this ophthalmia more especially when the surface of the snow, which covers the ground on all sides, has been partially melted, and again, by the action of frost, converted into a solid crust. To the incapability of bearing light, there is at first joined a disagreeable sensation, as if grains of sand had fallen into the eyes, which, as the disease advances, increases so as to resemble the effect of the strongest

* iv. 5. p. 291. 4th ed. of Hutchinson, Cambr. 1785.

† Knud Leem *on the Laplanders of Finmark*, p. 52.

‡ Crantz, *Historie von Groenland*, i. 297.

sternutatory powder, and they are seized, at the same time, with a very violent tonic blepharospasmus. These affections sometimes, though rarely, disappear in ten days, but not unfrequently they remain for four weeks*

Of the mechanical remedies used by the savages to prevent this blindness, which results from an intense glare of light reflected from the snow, I may mention two which happen to be at hand; one of them is of the same kind as that mentioned by Xenophon, and is at the present day much in use in those northern countries,—*something black*, which is stretched before the eyes; that is, a sort of net-work or gauze, made of horse-hair, a little convex anteriorly, lest it should impede the free motion of the eyelids. There is a specimen of this preventive machine among the curiosities of our academic museum, presented by M. De Asch, to whom I am indebted for innumerable articles supplied to my collection of natural objects, with a note attached, signifying that it is in use among the Tartars, especially when hunting or travelling in winter, and that it is called in their language *Kaar-yoeslik*, which means *eye-bandage* †.

The other of these machines is constructed on a very different plan by the Esquimaux, on the coast of Labrador. Although we find many things related by Ellis, Crantz, and other authors, who have visited those eastern shores of America, regarding the wonderful sagacity with which the Greenlanders and Esquimaux construct their snow spectacles, or *snow eyes*, as they call them; yet, as they seemed to be neither very accurate nor clear, I applied to one of the missionaries that he might give me a more correct account of the matter, in as far as regarded the part of the country in which the colonies of his brethren had been established. This benevolent man afforded me the necessary information, and moreover sent me a specimen of those spectacles, made by the Esquimaux themselves of the colony of Hoffenthal, on the Labrador coast, and which, both

* Cartwright's *Journal during a Residence of nearly Sixteen Years on the Coast of Labrador*, vol. i. p. 102.

† Concerning a similar apparatus used by the Persians for preventing the snow ophthalmia, see Chardin's *Travels*, vol. i. p. 241.; and Bell of Antermony's *Travels*,

with respect to simplicity of design, and accuracy of adaptation to the end in view, testifies the great ingenuity and acuteness of these savages in alleviating the inconveniences of their mode of life.

A few words will suffice to illustrate the figures by which this machine is represented. It is made of a very smooth wooden substance, like poplar, of that remarkable, and, in as far as regards its origin, as yet enigmatical, kind, which is driven upon the northern shores of the globe. The posterior surface, which covers the nose, is pretty deeply cut, to prevent it obstructing the free motion of the eye There is a notch cut on each side, at the lower margin, which is applied to the cheeks, and which is scarcely subservient to any other purpose than to afford a passage to the tears, which are rapidly secreted in an inflamed eye. The upper margin of the fore side, is more prominent than the under, so as to protect the eye from the snow, or act as a shade in keeping off the sun's rays. The other side is blackened with soot, so as to absorb a part of the dazzling light. Lastly, the apertures made for vision are in the form of narrow slits, and so placed as to correspond with the eye, having the lids nearly closed. I have of late, unfortunately, had occasion to try this machine, being troubled with a severe and obstinate tonic blepharospasmus, which has continued for several months; and when it was necessary for me to look minutely at anatomical preparations, or other natural objects, in a clear light, I have found nothing of equal assistance, or so convenient, as these Esquimaux spectacles of which we speak. Moreover, what all have testified, who, seeing this machine in my museum, have made trial of it, —it answers the purpose of a telescope, and Ellis says, that the savages just mentioned, although they are less dazzled by the brightness of the snow, apply it to their eyes only with the view of observing remote objects more distinctly.*

2. *Remarkable Irritability of the Tongue.*

We shall begin with Ovid's description of the very lively irritability in a tongue that had been newly cut out, when he re-

* Page 143 Gottingen edition.

lates the cruel deed of Tereus King of Thrace, perpetrated upon Philomela the sister of his wife Procne *.

> ———— "Compressam forcipe linguam,
> Abstulit ense fero. Radix micat ultima linguæ,
> Ipsa jacet, terræque tremens immurmurat atræ,
> Utque salire solet mutilatæ cauda colubræ,
> Palpitat, et moriens dominæ vestigia quærit."

Which, in truth, I had been accustomed, as often as I read it, to refer to the well known licence of poets, who assume an equal power with painters in matters of this kind, until my own ocular experience taught me, that the description was in no way inconsistent with truth.

For when, contrary to the opinion which I had hitherto held, concerning the remarkable irritability of the tongue of men, and of other mammalia, I saw that Sir Everard Home, who has distinguished himself by his physiological investigations, so much diminished the *vis insita* of the organ in question, as to pronounce its muscular fibres to possess a smaller degree of irritability than almost any other part of the body †, I determined to satisfy myself regarding this point, as well by instituting experiments myself, as by consulting the observations of others.

And nowhere did I expect to find a richer harvest of observations upon this point, than in the numerous writings on the subject of the Hallerian irritability, in which innumerable experiments, instituted with the view of supporting or of subverting the doctrine of muscular excitement, are described.

But as it not unfrequently happens, with regard to disquisitions of this kind, that one may find among them every thing but just what he wants, this I found to be the case here also; and I was not a little surprised, that nothing occurred, either in the writings of the first President of our University, on the subject of his celebrated discovery, the heads of which are contained in the commentaries of the Royal Society, or in the works of others, whether his supporters or adversaries, in the way of experiment or observation upon the irritability of the tongue.

* Metamorphos. vi.

† *Philosophical Transactions* for 1803, p. 211. Observations on the structure of the Tongue. "The internal structure of the tongue is less irritable than almost any other organized part of the body."

Nor was I more fortunate in searching the writers upon Galvanism, as it is commonly termed, in which also I found myself baffled in the hopes which I had cherished.

In the great and immortal physiological work of Haller, which may be considered as forming the pandect of that study, all that is said upon the subject is contained within the short limit of a remark of three words, namely, "*irritabilitate lingua gaudet*,"—the tongue possesses irritability *.

As nothing, therefore, was to be gained by consulting authors, I began the more diligently to observe for myself, and, whenever an opportunity presented, cut out the tongues of warm-blooded animals, which had been killed for other purposes, of dogs, cats, goats, sheep and rabbits, and in all these, although there was a considerable difference in different individuals, even of the same species, I was struck with the irritability of the yet warm tongue, under the excitement of chemical as well as mechanical stimuli; of which experiment I may adduce one in the present place, as exactly corresponding with the description of Ovid.

I had the tongue of a four-year-old ox, which had been killed in the common way, by opening the large vessels of the neck, cut out in my presence, while yet warm, and at the same time the heart, in order that I might compare the oscillatory motion of this organ, which is by far the most irritable that we are acquainted with, with the motion of the tongue. And when I excited both viscera at the same time by the same mechanical stimuli, namely incisions of a knife, and pricks of a needle, the divided tongue appeared to all the bystanders to survive the heart, by more than seven minutes, and to retain the oscillations of its fibres altogether for a quarter of an hour; and so vivid were the movements, when I cut across the fore part of the tongue, that the butcher's wife compared them to those of an eel in a similar condition, quite in the way that Ovid has compared them to the motions of the tail of a mutilated snake.

To these observations made upon animals, I may add here a similar one made upon the human tongue itself, the knowledge of which I owe to my excellent friend and much respected colleague, Reimar.

* De corpori humani Fabricâ et Functionibus, ... p. 316.

A boy in Hamburgh, who was severely affected with epilepsy, bit the fore part of his tongue in a violent paroxysm, in such a manner that it adhered only by a thin slip. This segment, therefore, as being not only useless, but very inconvenient to the patient, it was immediately judged necessary to cut off: And when the physician, the illustrious Chaupefié, placed it upon his hand, he was surprised to see it palpitate strongly. In order, however, to guard against all deception, as the motion might have depended upon the action of the muscles of his hand, he placed the bit of tongue in the bottom of a window, and even then it continued to move for several minutes, insomuch that it even seemed, as all the bystanders testified with one accord, to change place a little, and creep forward. External stimuli, the prick of a needle, or the application of salt, also excited similar motion; scarcely, however, differing in any way from the spontaneous ones.

I am therefore much mistaken, if the muscular substance of the tongue is not possessed of a remarkable degree of irritability; and Ovid has described its phenomena with exquisite precision.

3. *The Xanthopsia of Jaundiced Persons.*

The opinion that objects are seen by people affected with jaundice of a yellow colour, has been so generally prevalent, for nearly two thousand years, that it has metaphorically passed into a saying. More particularly known is the passage of Lucretius on this subject

> Lurida -- fiunt quæcunque tuentur
> Arquati, quia luroris de corpore eorum
> Semina multa fiunt simulacris obvia rerum.
> Multaque sunt oculis in eorum denique mixta,
> Quæ contage sua palloribus omnia pingunt *.

In the same manner his cotemporary Varro says, that jaundiced and lethargic people see things, which are not in reality yellow, just as if they were so, and after these Galen †, and his numberless followers, down to Boerhaave ‡, and his adherents.

* Lib. iv. v. 333. et. seq.

† De Causis Symptomatum, vol. i. p. 2. and elsewhere.

‡ Prælect. in Institut. sect. 544 and 810.

Mercurialis * was the first, in as far as I know, who called this assertion, regarding the yellowish vision of those who labour under icterus, in doubt; and in later times Haller †, and Morgagni ‡, among others, have been similarly inclined.

Lastly, a middle opinion between the two has been held by many after Hoffmann §, Durazzini, Buzzi, and Percival ||, who acknowledged, that the yellow vision in question does indeed occur in some cases of icterus, though rarely, and who placed the fact beyond dispute by accurate investigation, as well as occasionally by the anatomical dissection of the eyes of patients who died of jaundice.

But, on consulting all these opinions with care, that rarer Xanthoöpia (as it may be called) of jaundiced persons, seems to be in this condition, that it supposes at first a yellowish tinge in the pellucid media which transmit the rays of light, especially of the aqueous humour and crystalline lens; then a not so gentle, but more sudden attack or increase of the disease; and, lastly, both a vivid perception in the sensorium and application of the mind. But as these seldom happen at once in icterus, we can easily comprehend why very few patients in that disease complain of the yellow tint of objects. On the contrary, I knew a lady of excellent talents and accomplishments, who, on a sudden and severe attack of icterus, saw at first linen of all kinds, towels, &c. of a livid or dusky hue, and as if they had been ill washed, or not properly bleached. But those, upon whom the disease seizes slowly, advancing as it were step by step, no more experience this yellow hue of objects than old people do, in whom we have known the crystalline lens become livid in very advanced age. Should this tinge take place in one eye only, the other remaining uncontaminated, that diversity of colour in white and shining objects, would be no less easy of observation, than in

* Variar. Lection. l. vi. p. 357. of the Paris ed. of 1585.

† Ad Boerhaav. Prælect. t. vi. l. c., and his Element. Physiol., and v. p. 488.

‡ De Sed. et Caus. Morbor. &c. ep. xxxvii. art. 8. vol. ii. p. 74. of the Venice ed. of 1761.

§ See his Works, v. iii. p. 302.

|| See his Works, Literary, Moral and Philosophical, ed. of 1807. v. ii. p. 228.

patients, who, after depression of cataract, see the objects, from the use of sulphate of copper applied to the diseased eye, on which they look with it, of a colour sometimes verging towards blue *. And a somewhat similar vitiation of sight is known to take place in those who have, for a long time, kept one eye applied to dioptrical instruments. Thus the celebrated philosopher, James Rohault, after looking, without interruption, for twelve hours, at a distant battle, by means of a telescope, from that time forth saw every object with his right eye, which he had here fatigued so much, of a different colour from what it had when viewed with the left. And the same circumstance happened to myself, after being assiduously employed, for several days, in making observations with a compound microscope.

But what is commonly told of the two celebrated painters, J. Jouvenet † and Gavin Hamilton ‡, does not appear at all likely, viz. that they did not apply the colours with great precision in their paintings, because they both laboured under a similar organic disease of the eyes, and so could not depict the colours of objects with the accuracy of nature. For although we allow a disease of this kind, yet we cannot but think that they saw their own paints in the same way that they saw the objects which they painted, so that they ought to appear to the spectators tempered in an equal manner, and so as to correspond with nature.

4. *On the Prickle at the extremity of the Tail of the Lion.*

Homer §, and many other ancient poets, both Greek and Latin, when they describe an enraged lion, relate that, as Lucan says ||, he stimulates himself with blows of his tail. And Pliny, indeed, calls the tail the index of the lion's mind; for, says he, " when the tail is at rest, the animal is quiet, gentle, and seems pleased, which is seldom, however, the case; and anger is much more frequent with him, in the commencement of which he lashes the ground, but as it increases, his sides, as if with the

* Jos. Mohrenheim in Wiener. Beytr. zur Practishen Arzneykunde, vol. I.

† Voltaire, in his Siecle de Louis XIV.

‡ According to the opinion of his illustrious friends Winckelmann and Mengs.

§ Iliad, Book xx.

|| Pharsalia, lib. i. 208.

view of rousing it to a higher pitch*." Again, Alexander Aphrodisiensis has among his problemata the following: "Why, since the moving of the tail is, in most animals, a sign of their recognition of friends, does the lion lash his sides when enraged, and the bull in the same manner?" †

But the ancient commentator of Homer, who commonly goes by the name of Didymus Alexandrinus, asserts, with reference to the place of the Iliad, which we have cited, "that the lion has a black prickle in its tail among the hair, like a horn, when punctured, with which it is still more irritated by the pain ‡." This opinion, however, which has been noticed also by late commentators §, we were the more disposed to take for a mere fiction, that no anatomist, who had possessed an opportunity of dissecting a lion, had hitherto made mention of any prickle of this kind ||.

I had the good fortune, however, when, through the munificence of a friend, to whom I owe so many splendid ornaments of my cabinet, I was presented with a lioness, which had died very soon before, to find, in consequence of an anxious search which I had made, in order to satisfy myself regarding the assertion of the Greek scholiast, a very small dark-coloured prickle in the very tip of the tail, as hard as a piece of horn, and surrounded at its base with an annular fold of the skin; and when I cautiously dissected the hide in this place, I found a singular follicle of a glandular appearance, to which the prickle firmly adhered. (See Plate IV. Fig. 8. in last Number.) All these parts, however, were so minute, and the little horny apex so buried among the tufted hairs of the tail, that the use attributed by the ancient scholiasts cannot be regarded

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* Lib. viii. † Problema cxlviii.

‡ Εχει δε τι εν τῃ ουρᾳ αναμεσον των τριχων κεντριον μελαν, ὡς κερατιον, ὑφ᾽ ὁ νυττομενος (some read τυπτομενος) πλεον αγριουται. p. 596. Oxf. Ed. 1695.

The same is more concisely repeated by *Eustathius*, at this place, and under the words ουρα and αρχιος.

§ See, for example, *Heyne* Observat. in Iliadem, Vol. ii. part 3. P. 43.

|| Even *Franc. Serao*, who gives an accurate description of the lion's tail, makes no mention of it.— See his *Considerazioni intorno alla fatta sopra un leone*, in the 69th page of his *Opuscoli di fisica e anatomia*

as any thing else than imaginary ; but the structure of the organ is so elegant, and its form so regular, that it cannot possibly be considered as fortuitous, or what is commonly called a *lusus naturæ.* I leave to others, who may have an opportunity, to inquire whether any variety be observable in its conformation and size, as connected with a difference of age or sex *.

5. *Domestic Sheep again become Wild*

As some kinds of domestic animals, hogs, for example, cats, rabbits, &c., are evidently referable to their original stocks, so, on the other hand, there are many others which seem so much altered from their original state, that they are now nowhere to be seen in nature, that is, in a wild state, nor can we pronounce with certainty what was their native country. Thus, it is impossible to say with precision, what was the original country of the horse or dog, provided care be taken not to confound the offspring of tame individuals, which have got loose and retired to uncultivated places, with truly wild animals, which have been so all along from their origin. For, to mention an example, whole herds of wild horses are now found in the woods of Paraguay, although, as is well known, no animals of the species existed in the New World, before the first arrival of the Spaniards there. In the same way, the classic Oviedo, one of the first writers on the New World, mentions that other species of domestic animals, dogs, cats, oxen and hogs, which had been brought to America by those Europeans who first took possession of it, had afterwards become wild by chance, and had propagated †.

In the same manner, numerous cases have been observed in Europe, of dogs, cats, goats, oxen and horses. Only of the sheep no example had hitherto occurred to me ‡, until, perusing

* We have observed a similar prickle at the extremity of the tail of the leopard. —Ed.

† On the subject of European dogs run wild in America, consult our noble friend Alex. de Humboldt, *Ansichten der Natur.* Part i. p. 87.

‡ For what Oldendorf says of sheep, which have become wild in the lofty mountains of the West India island Santa Cruz, does not appear to rest upon a very firm foundation.—See in *Geschichte der Mission der Evangelischen Brüder, &c.* vol. i. p. 81.

the very learned work of Vincentius, I fell upon the remarkable place where Nearchus, in his description of a sea voyage, relates, regarding the island Cataia, which was desert, and consecrated to Mercury and Venus, situated on the coast of Carmania, that the inhabitants of the neighbouring islands carried thither *sheep* and goats yearly, and sacrificed them to the god and goddess, and that these animals, in course of time, became wild in the deserts *. Concerning the wild sheep in Phrygia, of which Varro † mentions that many flocks are seen there, I cannot presume to decide. In the mean time, however, even these may be considered as domestic sheep run wild, with greater probability, than as being of the Capra Ammon species, as was the opinion of Pennant.

6. *The Genuine Opsian Stone.*

Not to leave Mineralogy altogether untouched in these miscellaneous notices, we embrace the opportunity of adding a few words regarding the Opsian Stone, afforded by the Periplus Maris Erythræi, which accurately points out the native place in which this fossil occurs on the coast of the Arabian Sea ‡. And, as I learned from the classical commentaries of the Dean of Westminster on the subject §, that the illustrious Salt, so celebrated for his travels in Ethiopia as well as in Arabia and the Indian Peninsula, had visited that place, found the opsian stone there, and brought it to England, and being desirous of seeing this hitherto problematical fossil, I was presented by our accomplished colleague with two of his specimens, which the above celebrated traveller had gathered on the sandy shores of the Ethiopian Gulph Howakih, North Lat. 15° 10′, in the month of January 1809 ‖; and which I was convinced would, at first sight, settle the various dissensions regarding the opsian and op-

* Ες ταυτην (νησον) όσα ετη αφιεται εκ των περιοικων προβατα και αιγες, ιερα τω Ερμη και τη Αφροδιτη. Και ταυτα απηγγελμενα ην οραν υπο χρονου τε και ερημιης. (p. 59.)

† Page 238. Gesner's Edition.

‡ *Commerce and Navigation of the Ancients in the Indian Ocean*, in two volumes, London, 1807, to which are added the *Voyage of Nearchus*, and the *Periplus of the Erythræan Sea*, Oxford, 1809, by William Vincent.

§ Ibid. ‖ Salt's *Voyage to Abyssinia*, London, 1814, p. 192.

sidian stone *, as will appear from the oryctognostic description, made up from the specimens which I have in my possession.

The colour of this stone was raven-black; but on one surface of polished specimens there was an appearance of parallel streaks, of a somewhat paler colour.

The form in which it occurs is subglobular, obtusely angular, which is compared by Vincent to that of a potato.

The size of the specimens is that of some inches in diameter.

Lustre intermediate between pitchy and glassy.

Fracture small conchoidal.

Opaque, unless in very thin plates, which, in the light of a candle, are somewhat translucent, passing from grey to deep leek-green.

Hardness very great, admitting a high polish.

Specific gravity, 2.410.

All these circumstances, in short, demonstrate, that the genuine Æthiopic opsian stone, again discovered of late years, but hitherto seen by very few mineralogists, is identically the same with the common *Obsidian*, which used formerly to go by the improper name of Iceland Agate.

Art. VII.—*Account of the Methods employed for Examining the Population Returns of Plymouth for the year* 1821, *and the consequent discovery of the Registered Seamen having been included in the Census of* 1811, *contrary to the terms of the Act of Parliament relating to the Population of the United Kingdom.* By George Harvey, Esq. M.A.S., M.G.S., &c. &c.

In a note attached to the first part of my Essay on the American Population, printed in the preceding Number of the Edinburgh Philosophical Journal, I briefly alluded to a plan which was successfully carried into execution at Plymouth, in the year 1821, for ascertaining the population of that place,

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* c. I. Inprimis Andr. Libanii Singularium, p. iii. p. 796.—Salmasius in Solinum, p. 91. 204.—C. de Caylus in Mém. de l'Acad. des Inscriptions, vol. xxx. p. 457.—Ad. Fabroni in Opuscoli scelti sulle scienze e sulle arte, t. xi. p. 369.—Andr. I. Retzii, Observ. de lapide obsidiano. Lond. 1799, 4., et Chr. Aug. Schwarz de Theophrasti Lepareo lapide, Gorlit. 1801, fol.

and by which means the number of inhabitants was very correctly ascertained, and much useful information derived from the attempt, as a groundwork for other inquiries of a like kind. In the progress of the investigation, however, it happened, that some uncertainty appeared to exist in the population returns for one of the two parishes composing the town; and upon submitting the results of each parish to the operation of the same algebraical test, the conclusions were not found to accord with each other. The details of the inquiry may possibly be of some practical utility to the cultivator of statistics; and hence a short account of the investigations which led to the curious discovery of the Registered Seamen having been included in the former census of the people, is added for his satisfaction.

In the note before alluded to, it was remarked, that the town was divided into a number of small sections, and two gentlemen appointed to each. The returns for each section were collected as soon as the enumeration was completed, and the aggregate amount of the houses, families, persons, and other particulars relative to the census, was then found for each parish, and from which the following comparative Table was deduced, by comparing the several results with the corresponding particulars in the returns of 1811.

	Parish of St Andrew.		Parish of Charles.	
Inhabited Houses,	Increment,	157	Increment,	180
Families, -	Increment,	124	Increment,	75
Persons, -	Decrement,	133	Increment,	921

On finding large increments in all the particulars appertaining to the parish of Charles, and that the inhabited houses, and families of St Andrew, likewise presented additions of a corresponding kind, but that in the *persons* actually enumerated, there was a *decrement*, some curiosity was necessarily excited, as to the causes which could have possibly produced results of so very dissimilar a nature, in two parishes perfectly contiguous to each other, subject to the same vicissitudes of mortality, and influenced in corresponding degrees by the ordinary tide of events.

The first natural step in an inquiry of this kind, was to discover how far the supposed anomaly was sanctioned by the registers of marriages, baptisms and deaths, preserved in the parish records. A reference to these, however, only tended to

prove that some mystery hung over the returns of the male population of St Andrew, because the marriages and baptisms of this parish had received very large additions during the preceding ten years; and the register of burials for the same period also proved, that no undue rate of mortality had prevailed, so as in any way to account for a decrement in its population. To discover, therefore, the probable cause of the anomaly, it was deemed expedient to submit the returns of each parish to the test of the same law; and for this purpose, the principle was employed, of supposing *the annual average excess of baptisms above burials, to bear a constant ratio to the contemporaneous population;* and the proper application of which theory, furnishes the equation

$$A = P(1 + l)^n,$$

in which A denotes the *present* population of a parish, P the amount of its population, when the former enumeration was made, n the elapsed interval in years, and l the number arising from the division of the average annual excess of baptisms above burials, by the antecedent population of the place. In the present case, the values of these elements are as follows, for the respective parishes.

St Andrew.	Charles.
$P = 12339$	$P = 8464$
$n = 10$	$n = 10$
$l = .0106$	$l = .0106$

Hence, by adapting the representative equation for the *present* state of the population to logarithms, it will assume the form of

$$lA = lP + n\,l(1 + l),$$

and which, by applying the numerical elements for the respective parishes, will furnish the following calculation for St Andrew:

$$\begin{array}{rcrcl} lP & = & l\,12339 & = & 4\cdot0902800 \\ n\,l(1+l) & = & 10\,l\,1\cdot0106 & = & 0\cdot0457930 \\ \hline lA & = & 13680 & = & 4\cdot1360730 \\ \hline \end{array}$$

and a similar application will likewise afford the following for Charles:

$$
\begin{aligned}
lP' &= l\,8464 = 3{\cdot}9275757 \\
n\,l(1+l) &= 10\,l\,1.0106 = 0{\cdot}0457930 \\
\hline
lA &= 9405 = 3{\cdot}9733687
\end{aligned}
$$

Now, the enumerations of the same parishes in 1821, gave, for St Andrew, a population of 12,206, and for Charles 9,385; the logarithmic computation approximating to the actual population of the latter parish within twenty persons, but differing from the enumeration of the former by no less a number than 1474 persons.

It was now resolved to submit the subject to another test; and for which purpose, a principle formerly employed by Dr Price, for ascertaining the amount of a population, was adopted, viz. "*Multiply the expectation of an infant just born, by the number of yearly births, and the result will be the number of inhabitants.*" This hypothesis, it was well understood at the time, was not strictly applicable to Plymouth, because it is founded on the supposition that the yearly births and deaths are equal, —a principle, perhaps, not to be applied without some qualification to any town in England, on account of the many powerful causes which are now in active operation to diminish the rate of mortality, and thereby to augment the entire population of the country. Still, as a test applied to both parishes on the same common basis, no reasonable objection can perhaps be urged against it; and if we therefore adopt 373 as the average number of births or deaths for St Andrew, and 256 for the parish of Charles, and also consider the expectation of an infant at birth as 36.5 years, we shall obtain the following results for the population of the two parishes, viz.

For St Andrew, - -	13614
For Charles, - -	9344

the latter of which approximates to within 41 persons of its actual population; but the former again differs from the result of its enumeration, by no less a number than 1408 persons.

In the following Table, the different conclusions are brought into one point of view, and by which we may perceive how nearly the two hypotheses which have been adopted for the parish

of Charles accord with the actual returns of that parish; and how wide is their difference, with respect to that of St Andrew.

TABLE OF RESULTS.

	St Andrew.	Charles.
By actual Enumeration in 1821, - -	12206	9385
By supposing the average Excess of Baptisms above Burials to bear a constant ratio to the Population,	13680	9405
By supposing, according to Dr Price, an Equality in the Births and Deaths, - - - -	13614	9344
Mean of the two hypotheses, - - -	13647	9374
Difference between the actual Enumeration and the Mean, - - - - -	1441	11

After examining this Table of Results, and observing the close approximation of the resulting numbers for one parish, and the discordance which reigns among the results of the other, there could be but little room for doubting that some error existed, either in the present or preceding returns of St Andrew's parish. An accidental conversation, however, between the overseers of 1811 and 1821, fortunately led to the discovery, that the Registered Seamen belonging to the port, and which, by one of the enactments of the act relative to the population, ought to be omitted in every case, were nevertheless actually *included in the census of* 1811; and on making application to the proper officer of the Customs, it was found, that *the Registered Seamen for the last-mentioned period amounted to* 1424, *agreeing within* 17 *of the mean of the two hypotheses adopted as tests*,—a coincidence most striking and remarkable, and affording a strong proof of the accuracy of the principles which had been adopted.

Such coincidences stamp a value on the practical applications of mathematical science. It proves, by a species of evidence of the most unquestionable kind, that, notwithstanding all that has been urged against employing algebraical analysis to the details of population, and to other subjects of a kindred nature, much solid and useful information is frequently to be gained, by a judicious application of its powers; that many errors may be removed by its means, from the increasing mass of our experimental results; and that very often, as every one accustomed to pursue trains of analytical inquiry must have found, new views are opened of the subject under consideration, and its various elements brought under the controul of some generalizing prin-

ciple, and which in its consequences leads to results of the highest importance and value to man. This is not, however, the proper place to insist particularly on the advantages which have resulted to the various branches of physical science, from the application of mathematical symbols and signs,—from their definite phraseology,—from the fixed and unchangeable relations which form the proper objects of the science, and which so often imparts its own precision to those branches of knowledge to which it is applied, although, to have omitted alluding to the subject, would have been improper, after the striking coincidences which have been above obtained.

Art. VIII.—*On the Crystallographic Discoveries and Systems of* Mohs *and* Weiss. In a Letter from Frederick Mohs, Esq. Professor of Mineralogy at Freyberg, to Professor Jameson, in Answer to that of Professor Weiss, in the last Number of this Journal (Page 103, &c.)

Sir,

I find it necessary to communicate to you a few observations, that have offered themselves to me, on reading the letter from Prof. Weiss, inserted in Number 15. of the Edinburgh Philosophical Journal, which you had the kindness to transmit to me. In this letter M. Weiss accuses me of having borrowed from him without acknowledgment, and claims at the same time for himself the establishment of the systems of crystallization, under which I have assembled the regular forms produced by nature. He considers himself as the original source of all information on this subject, and seems to intimate in his letter, that he has rather invented than abstracted those systems from nature. I believe, therefore, I must begin my communications respecting them, with stating the manner in which I have been led by degrees to their development.

You know that, from the time I first became acquainted with minerals and mineralogy, I entertained the opinion that this science should form a part of *Natural History*, and as such be treated according to the principles received in Zoology and Botany. This at least will occur to your memory, if you reflect

on the many conversations I had with you, and our late excellent friend Dr Mitchell, at Freyberg, or advert to the catalogue of a famous collection of minerals which I published at Vienna, some years afterwards. The principles I adopted in this work, although not then reduced to their present purity and simplicity, by no means differ from those which I still acknowledge; and I trust that I have at least put beyond all doubt the possibility of a natural history method in mineralogy, by a strict adherence to those principles.

After having developed and settled with myself clear ideas of the different single parts that constitute the natural history of the mineral kingdom, I now fixed my attention more particularly upon that which is called the *Characteristic*. It was obvious to me, that the application of the characteristic required an examination of the properties of minerals, in order to obtain such as might be usefully employed as characters; and that those which are derived from the regular forms could not here be neglected. I could not make any use of the descriptions of crystals, conducted according to the methods hitherto employed; because it was not my object to unfold the variety of nature, but, on the contrary, *to collect* this variety under *one and the same idea*. I found, also, that the Abbé Haüy's Primitive Forms were equally inapplicable to my purpose, for they do not contain the image of that variety which I more particularly intended to represent in the characters.

The four rhombohedrons of calcareous-spar *(rhombohedral lime haloide)*, designated in Haüy's works by the letters *m*, *f*, *p*, *g*, possess the property, that, their axes being supposed equal, the faces of every more obtuse rhombohedron are tangent to the terminal edges of every more acute one; and, consequently, if the horizontal projections are supposed equal, that their axes decrease in the ratio of the powers of the number 2. Nothing could be more simple than to apply to these forms the notions of the *series of characters* which I had previously made use of, and found to be very well adapted to many purposes. Thus, I derived the *series of rhombohedrons between its limits*, with which you are sufficiently acquainted.

I had made the remark, that some of the forms which the celebrated Werner considered as fundamental in his descriptions

of crystals. consist of, or are contained under, faces all equal and similar to each other; and that those faces which arise from truncations, acuminations, and bevelments, lead to similar forms, if the homologous planes are duly enlarged, and followed up till the rest of the face disappear,—a remark that cannot fail to present itself to every observer. I founded upon it the division of the whole crystalline forms into *simple* and *compound forms*, to the latter of which I gave the name of *combinations*, in a sense somewhat different from that of Haüy, who called simple forms *des combinaisons une à une*, and, always proceeding from his theory, rather meant by them combinations of laws of decrement, than combinations of the forms themselves.

Some of the combinations, besides rhombohedrons, contain at the same time several other forms. By the same modes which afforded the series of rhombohedrons, I was very soon led to the method of deriving those forms likewise from the rhombohedron, and of arranging them into series. Thus, I established the idea of an assemblage of several series of forms, homogeneous among themselves, each of these series having its particular limits, and composed of members, that, by *the relations they bear to each other, acquire the property of entering into those combinations which nature produces.* These series I have called *series of crystallizations*, in order to distinguish them from the single series of homogeneous simple forms of which they consist.

If we examine the productions of nature, according to the idea of the series of crystallization thus developed, we find that some of them very nearly agree with each other, inasmuch as their series of crystallization consist of similar series of simple forms; while others, similar among themselves, differ entirely from the former, inasmuch as they do not contain any one of the series which constitute these: but nevertheless consist of other series of simple forms, similarly connected among themselves, and likewise contained within their regular limits. For this reason, I found it necessary to render more striking the connections which exist among the former, and the differences between those and the latter, which again required a further subdivision; and this I have effected, by giving the name of a *System of Crystallization* to every assemblage of homogeneous series of crystallizations. The four systems established in this manner I have called, as

you know, the *Rhombohedral*, the *Pyramidal*, the *Prismatic*, and the *Tessular* System.

Here I must request you to direct your attention more particularly to two points. I have to observe, in the first place, that *my* systems of crystallizations are founded upon very simple observations, and upon such inferences from them as may be deduced with the greatest facility. I have always explained in the same manner as I do now, the three notions developed above, viz. that of *a System of Crystallization*, that of *a Series of Crystallization*, and that of *a Series of Homogeneous Forms*, which are subordinate to each other; but of which, at least the first and second have been almost continually confounded by most authors, whose conceptions of them have not been sufficiently clear. My second remark is, that, by establishing these systems and series of crystallization, I had entirely fulfilled my *intention*, which was to *obtain characters*; a subject with which you are sufficiently acquainted, by the mode in which it has been performed.

This is the quality and the origin of what I have designated by the words System of Crystallization; and these systems, both in quality and origin, are different from what other crystallographers, and more particularly the *Abbé Haüy* and *Professor Weiss*, mean by the same denomination. I have likewise pointed out the way by which I have gradually been led to the development of these notions.

I must not neglect the opportunity afforded me here, of mentioning the assistance which I have received from my friend M. W. Haidinger, in the development of the series, the calculations, measurement, &c., to which I attribute the rapid progress of my crystallographic method. M. Haidinger enjoys the honour of your personal acquaintance, and before now I have mentioned the circumstance more than once to you; yet I have thought it necessary to repeat it here, that I may not seem to consider myself guilty of the fault which M. Weiss has laid to my charge.

I was occupied with the different crystallographic subjects of which I have just now given the historical details, during the years 1812,–14, in the autumn and winter of the last of which I for the first time brought the whole of it into systematic or-

der. From this time, I regularly employed the method in my lectures at Gratz, in place of the imperfect fragments I had hitherto been obliged to employ. Many persons, with whom I was in connexion at that time, are perfectly acquainted with all the particulars which I have just stated. I shall only mention, besides M. Haidinger, the Chevalier Thinnfeld, with whom you are likewise personally acquainted, Mr Riepl, Professor at the Polytechnical Institute at Vienna, and Professor Anker, my successor in the chair at Gratz, all of whom I had at that time the pleasure to rank among my pupils, and *who will at all times be ready to bear testimony in the most decided manner to what I have advanced.*

Up to that period, the publications of Professor Weiss referring to the present subject, had consisted only of the paper *De indagando Formarum Crystallinarum Charactere Geometrico Principali*, and its continuation, printed at Leipsig 1809; two dissertations I never have seen, but in the form of a translation, which I met a considerable time afterwards in the *Journal des Mines.* M. Brochant de Villiers, the translator, has prefixed the contents of this memoir to his translation; but he does not point out in it any of those connexions among the forms that might lead the reader to the notion of the real systems of crystallization; he only mentions that the author, in order to express the geometrical character of some of the forms, has been forced to substitute others in their place, as, for instance, a rhombohedron in the place of the regular six-sided prism, and that this gave rise to several very interesting approximations. Such are, besides the one mentioned, that of the rectangular four-sided prism, with the isosceles four-sided pyramid (octohedron), and that of the oblique-angular four-sided prism, with a four-sided pyramid (octohedron) of an elongated basis. The latter of these, however, is a compound form as well as the prism, in the place of which it has been substituted. He also remarks, that M. Haüy, too, had long ago shown the possibility of similar transmutations, and effected them in several examples, and that Professor Weiss in this had proceeded from the very ideas and discoveries of M. Haüy himself.

Indeed, M. Haüy has effected this transmutation in every case, where he employs for his primitive form any combination

whatever that contains a prism, which, by itself, is a form of infinite dimensions. For he indicates finite dimensions of such forms, and these he must derive from the dimensions of a secondary simple form of the species, by which proceeding, in fact, that secondary one becomes the real fundamental form. Thus, if we do not attend to the mere geometrical distribution of Haüy's primitive forms (which indeed has never been prejudicial to his determinations), we find in his works not only those approximations which Professor Weiss mentions in his memoir, but also several others, at least as interesting as these, and which might very well lead to what M. Weiss calls Systems of Crystallization, *provided we have previously conceived a correct idea of these assemblages.*

In the same memoir, M. Weiss confounds, or at least does not sufficiently distinguish between the dirhombohedrons and the isosceles six-sided pyramids, an inaccuracy introduced by Haüy, and not removed by M. Weiss, since it is still to be found in his most recent papers. Yet the accurate distinction of these forms is of the greatest importance. It is, however, impossible to get at it, without possessing correct ideas respecting the simple forms and their combinations, the position which the former affect, and the series which they constitute.

I shall not deny that a person who is already acquainted with these assemblages, may trace the first rudiments of Professor Weiss's System of Crystallization in the memoir in question; yet, on the other hand, we cannot but confess that it is impossible to be led to them by these papers. On this account at least, I do not see any reason why I should regret the loss I may have incurred by my late acquaintance with them.

The paper of Professor Weiss, to which we must here attend more particularly, is his General Exhibition of the *Different Natural Divisions of the Systems of Crystallisation*, read 14th December 1815. The Memoirs of the Society of Berlin of the year 1815 came out in 1818; the above paper of Professor Weiss, therefore, was not printed, or at least not published, till that time. Professor Weiss has had the kindness to present me with several of his later papers, exactly as he remarks in his letter; that one was not among the number, because, he says, I was at that time "at a distance from my place

of residence." You will remember that *at that time I was in England.*

Some time after my return to Germany I became acquainted with the existence of that paper, more particularly by M. Hausmann's work, "*Inquiries into the Forms of Inorganic Nature.*" This excited in me a desire of perusing it. It was not to be found in the library of the Academy of Freyberg. *M. Breithaupt*, some time ago, had promised to send me it; this promise was fulfilled on the 24th December 1822, after I had again put him in mind of it, on the occasion of what Professor Weiss calls his claims to my systems of crystallisation.

If you examine this paper, you will remark that it agrees very closely with what is contained in the second edition of my Characteristic, respecting the *kind* of the forms within the different systems: an agreement which you will find still greater, if you compare it with the first volume of the *Treatise on Mineralogy*, which I have lately published, and of which M. Haidinger is preparing an English translation. In this treatise, the description of the forms of the tessular system are very often expressed, almost with the same words as those of Professor Weiss. This coincidence, so far as it goes, is remarkable enough; and, in order to account for it, I shall proceed with my historical statements.

Things being, at the end of 1814, in the condition which I have mentioned above, I considered the composing of an elementary work on mineralogy, as an undertaking both useful and necessary. I directed my attention, in consequence, to the construction of such a work, and, before the end of 1816, the manuscript was completed. Of this work, the paper which you afterwards inserted into your Journal, but which was written in the same year, must be considered as a short extract; the only intention of which was, to give *yourself* a precursory general idea of my method.

The manuscript having thus been completed, and answering entirely to the then existing knowledge of mineral productions, I had determined to publish it immediately; but in this I was prevented by my journey to England. On this journey, when I left Freyberg, the 3d December 1817, I carried the said manuscript along with me, in order to give you a *more extensive* view

of the Natural History Method in mineralogy; and during my stay at Edinburgh, in the spring of 1818, this manuscript, together with the drawings belonging to it, and a collection of models I had got made in Gartz, for the purpose of illustrating the series of crystallization, was two months in your hands: you yourself translated some passages from it, and inserted them, according to mutual agreement, into the third edition of your valuable System of Mineralogy.

You are not, however, the only person in Edinburgh who at that time became acquainted with my method, and what belongs to it; for I had the honour of explaining the series and the systems of crystallization, with the assistance of my models, to *Mr Thomas Allan*, *Captain Brown*, and the late *Professor Playfair*, in the presence of *Count Breunner*, whom I accompanied on this journey *. *Dr Von Schreibers*, the Director of the Imperial Collections of Natural History at Vienna, has likewise, at a very early date, been acquainted with all these subjects; and at least a year previous to the composition of the manuscript, I communicated to him a paper containing a succinct view of my method, the exact contents of which, however, I cannot now indicate with certainty.

On my road to England I also touched at Berlin, where I more than once had the pleasure of conversing with Professor Weiss. If at that time he had mentioned his paper, or if it had been printed, and had communicated it to me, it would have put it in my power to lay before him my manuscript. Even if, after my arrival at Freyberg, he had sent it to me, I might have answered with that part of the manuscript still in my possession, which refers to Crystallography; and, I dare say, Professor Weiss would have convinced himself, in the most direct way, that, when I came to Freyberg, I in reality knew more of the matter than he explained in his Memoir *De Indagando*, &c.

The manuscript contains almost every thing you will find in the first volume of my Treatise on Mineralogy, excepting the introduction, for which I have substituted a shorter one. As to the crystallographic part, it contains, 1*st*, A general consideration of the forms, enlarged afterwards only by a few definitions. 2*dly*,

* M. Mohs also explained his System of Crystallography to Dr Brewster.—Ed.

The description of the simple forms of all the systems, with the same words as in the treatise, only sometimes more detailed; together with the indication of the dimensions relative to the known varieties of the tessular forms. There is also mentioned the difference of the pentagonal icositetrahedrons, and of the tetrahedral pentagonal dodecahedrons, according to right and left, which certainly could not be deduced from M. Weiss's paper on Felspar, in the *Journal of Schweigger*; because in this, as far as I remember, the author extends his consideration only to compound minerals, in the composition of which the individuals themselves are not in the relation of right and left. *3dly*, The general method, and the different proceedings of derivation, with the series of the homogeneous simple forms arising from them. *4thly*, The complete resolution of the seven principal forms of the tessular system, their halves and fourths. *5thly*, The general notions of the series and of the systems of crystallization, the latter of which I have always defined to be *the Assemblage of Homogeneous Series of Crystallization.* *6thly*, The general laws of combination; and, *7thly*, Several examples of their development.

Of these combinations one is dirhombohedral; two are hemiprismatic; four semitessular; and among these three of parallel, and one of inclined faces. I had not, indeed, at that time made use of three denominations, which I afterwards introduced; and to which, besides, Professor Weiss does not raise any claims. But I have constantly expressed the same crystallographic signs which I still retain.

For the truth of this I appeal to you and to Count Breunner, who is as intimately acquainted with the manuscript as yourself. I may add Captain Pringle, one of your pupils, who accompanied me on my return to Germany, and who studied it very diligently during his stay at Freyberg. If you read Professor Weiss's paper, you will not, after the perusal of my manuscript, find any thing new in it. But you will in vain search for what I consider to be the most important part of the manuscript; and, therefore, even though I should incur the risk of lengthening too much this defence, I shall still, for a moment, trespass upon your patience.

The agreement between the system of crystallization of M. Weiss and my own, extends only to the *exterior of the latter*, and has no reference whatever to the arrangement in their interior. "To connect several things, according to characters common to them all, does not produce a *system*, but only an *aggregate*. If there exist several characters of that kind, or several differences in one character, we obtain several similar aggregates, and effect a division." Thus, the systems of crystallization of Professor Weiss may be considered as divisions of the crystalline forms, according to those characteristic terms to which he refers their geometrical character; and he would have expressed this rigorously, if, instead of Systems of Crystallization in the title of his memoir, he had said Forms of Crystallization. To every division of that kind, it is necessary to refer all such forms as exhibit the same geometrical character; but among these forms themselves there exists no connection, because *such a connection cannot be a consequence of their aggregation.*

Under these circumstances, we are led immediately to that connection of the forms in the interior of the system, from which, as an *immediate and necessary consequence, flows* their aggregation; or what Professor Weiss understands by his systems of crystallization. The systems of crystallization of my method, therefore, are not mere aggregates, but true systems; and, for this reason, essentially different from the systems of Professor Weiss; and although both of them refer to the same objects in nature, yet it is only in my systems that every single form occupies that particular place which is assigned to it by its relations to all the others; the very property upon which is founded the true character of every system.

Upon this property depends also the most important use that can be made of the systems and series of crystallization,—which I consider to be that which refers to the natural history species in the mineral kingdom. If, with Haüy, we confine the notion of the species to the agreement of the individuals in both their integral molecules and their chemical constitution, or if, in general, we confine it to the agreement in one or several characters, that notion will be so very deficient in many respects, that it cannot become of any use in a natural system; for it does not contain any thing of *that highly remarkable con-*

nection by which nature has joined the homogeneous individuals. But we will find the same notion sufficient *for every* purpose, if we add it to the series in the characters, of which the series of crystallization ought to be first considered.

The importance of the series in general is so great, and their existence so obvious to every accurate observer of nature, particularly in the combinations, and in the parallelism of the edges thus produced, that inadvertence to this can only be explained by some unnatural distribution, by some theory like that of the integrant molecule, or by some artificial character. On account of their importance, I have taken the pains of examining all those of M. Weiss's memoirs I could get at, to see whether I could not find any traces of such series. Indeed, in a paper on Cubicite, (rhombohedral kouphone-spar) M. Weiss mentions the two most common rhombohedrons of calcareous spar, (rhombohedral calc haloide), of which "the more obtuse arises from the equally inclined truncation of the terminal edges of the more acute one;" and he remarks, that, "according to the same law, there exists a second more obtuse one, and a second more acute one, a third, &c." He adds, "In every rhombohedral system, all of these produce *a principal series of rhombohedrons*, with the first members of which those more particularly occurring in every such system commonly coincide, and, *between which*, those that may happen to occur conveniently may be interpolated." By this addition, "*between which*, &c." he again extinguishes that light which observation had kindled. Besides this place, mention is made of series only in the Memoir on Epidote; but there are series in the cosines according to odd numbers, which cannot be referred to our subject.

I leave the present subject with the remark, that the systems of crystallization of my method, cannot admit of any such subdivisions as M. Weiss has introduced into his. In this property, too, they resemble the general notion of the natural history species in the mineral kingdom, which admits of no divisions in subspecies. The differences occurring within the system in certain series of crystallization, refer only to *Peculiarities in the Combinations* of the simple forms. I have indicated these in both editions of the Characteristic, but more distinctly in the second, and in the first volume of the Treatise; in the second volume I have called them the *Character of the Combinations.*

I have never introduced or received divisions *within* the systems of crystallization, and never can acknowledge as such those of M. Weiss, since they are quite contradictory to my conceptions of the systems of crystallization. It might, however, in future, become necessary to adopt new *Systems* of crystallization, which are indicated by the inclination of the axis, a highly remarkable phenomenon noticed in several forms of the prismatic system in the first outline of my Treatise. The pursuit of this phenomenon will probably lead to *new fundamental forms*, of which new systems of crystallization are the necessary consequence. I have not yet fully developed the theory of these forms; it would therefore be premature to say more on the subject: it is, however, exceedingly probable that the properties of the axes of double refraction will be found exactly to correspond with these new fundamental forms, in the same manner as Dr Brewster has found them to be connected with what had previously been known of the crystalline forms.

Lastly, I have to add a few remarks regarding some other particular points in M. Weiss's letter, that I may not, at another time, be under the necessity of returning to these and similar matters.

M. Weiss strongly objects to my *denominations* of the systems of crystallization, and to my *crystallographic signs*. Both of them, as I have stated above, rest upon the series. The denominations, moreover, must possess such properties as may render them applicable and useful in the *mineralogical* nomenclature, for the sake of which they have been introduced; and, among these properties, besides precision in their meaning, brevity in expression is one of the most desirable. Professor Weiss's denominations being very defective, at least in the latter respect, do not allow of any application to the mineralogical nomenclature; and mine, therefore, even if we should dispense with other reasons, deserve, in this respect, a decided preference.

My crystallographic designation represents either the fundamental, or that form which is obtained from it by means of derivation, in the different places of the series of homogeneous forms contained in the series of crystallization; which, in my opinion, is the most important relation among these forms that deserves to be expressed in the designation. Thus it expresses *the form itself*, and besides this, its *connection with all other*

forms of the whole series of crystallization, in which it must be considered, if we wish to acquire a distinct and satisfactory knowledge of it. The signs of Professor Weiss represent single faces, and nothing of that connection which distinguishes my method of designation. As to the perspicuity and facility in the employment of my signs, in comparison with those of M. Weiss, I leave this to your own judgment, and to that of all who may choose to occupy themselves with the matter. I am far from supposing these designations, or, in fact, any part of my method already brought to such a degree of perfection, as to be incapable of any improvement or simplification. But I believe, that although M. Weiss means to intimate as much of his own, yet he will find considerable difficulties, in the way he now pursues, in conferring upon his denominations and signs those advantages which mine already possess.

I have, in the second edition of my Characteristic, adopted the angles given by Professor Weiss, of *felspar* (prismatic felspar), in preference to all others, because this species is one of those which have, from the earliest period, been the particular object of his inquiries, in which he was assisted by an exquisite collection of its varieties, formed by himself with much zeal and knowledge. The reason why his name has not been mentioned is, that I had reserved all similar citations for the second volume of my Treatise. Yet these demonstrations have been found incorrect, by the measurements instituted by M. Haidinger, with perfect individuals of the species, through means of the reflecting goniometer. The terminal edge of the fundamental form, given by M. Weiss as $= 126° \ 52' \ 11''.5$, has been found $= 126° \ 12'$; the more obtuse angle of the vertical prism, which he assumes as $= 120°$, $= 118° \ 52'$. A third datum to be depended upon for calculating the inclination of the axis is still wanted; for this reason, in the mean time, the inclination has been supposed $= 0$. In this manner you will find the indication of the forms of prismatic felspar in the first volume of my Treatise.

This seems to me a proper place for mentioning a fact respecting what has hitherto been called Felspar, which is still more important than the accurate estimation of the angles. This species, besides prismatic felspar, contains the varieties of at least two or three other species, differing in several of their

properties, but especially in their form, some of which even are not hemi- but tetarto-prismatic. Thus, in the greater part of the varieties of the Common Felspar of Werner, and in some of his Adularia, which varieties I consider to belong, with the Albite of Berzelius, to one and the same species, the inclination of the two most apparent faces of cleavage is = 93° 20′ and 86° 40′, instead of 90, as in prismatic felspar. A similar difference in the angles has also been noticed by Professor Fuchs of Landshut, with respect to what he calls Porcelain-Spar *.

In *Epidote* (prismatoidal augite-spar) M. Weiss says, that I had given the system of crystallization as unknown. Yet both the editions state the system of crystallization to be prismatic, and the combination hemiprismatic; only I would not give the dimensions of the fundamental form, because I suspected the correctness of Haüy's data, just like Professor Weiss, who did not, however, improve them by immediate measurements. You will find in the Treatise a new determination founded upon an accurate measurement of the angles. In this I have given the fundamental forms another position, different from that of Weiss, who had already rejected Haüy's; and if you will compare the relations of the derived forms, mentioned in both the volumes of the Treatise, with those of Professor Weiss, the greater degree of simplicity, which distinguishes the former, will not escape your attention.

The series of crystallizations of Cross-stone (paratomous kouphone-spar) certainly belongs to the prismatic, not to the pyramidal system, as Professor Weiss says. The prismatic system is indicated by the horizontal prisms that appear in the combination, by the striæ of the faces of the pyramid, and by cleavage, which is different in the direction of the different faces of the four-sided prism, and proves this to be a compound form, even if the termination is not taken into account. The dimensions of Haüy are certainly incorrect; but as yet we have no better. It is more than probable, that accurate measurement will exhibit a difference in the terminal edges of the fundamental form, however small this should be found. A transition from one system

* We think the application of the optical character to the felspar would lead to curious and important results, and therefore recommend this investigation to the attention of optical mineralogists.—ED.

to the other, by which Professor Weiss endeavours to remove the difficulty, is no less exceptionable than a transition from one species into the other.

The forms of *sulphate of magnesia* (prismatic epsom salt) are evidently prismatic, as you see from the dimensions given in the treatise. The prismatoidal cleavage likewise proves this incontestibly. A single perfect cleavage in the pyramidal system must be perpendicular to the axis; but in the present species, a position of that kind would produce forms still more incompatible with the pyramidal system. Professor Mitscherlich also attributes the prismatic system to this species.

The system to which we must refer the forms of *Wolfram* (prismatic Scheelium-ore) is likewise by no means the pyramidal system, although, if we should give *no attention to Nature*, and to the character of the combinations, Haüy's data might lead us to suppose this to be so. But the measurements, or rather the indications of the angles of Hauy, have, in so many instances, been found incorrect, that we can no longer attach any certainty to their exactness. We shall be the less induced to do so, the more we find these angles in direct opposition to other important observations, which, indeed, are so very obvious in Wolfram.

I shall not expatiate any more upon certain other subjects of Professor Weiss's letter. I declare, that I consider as quite unintelligible what he says of *the polarization of the faces, the axes, and the sides of lines in the crystalline structure, &c.* The data in nature, to which all this refers, are evident in themselves; and I do not think the science promoted, or such phenomena explained, and far less their "*physical principles demonstrated,*" if they are hid in obscure phrases, which tend only to give full scope to imaginary speculations.

Without the least intention to detract from, or depreciate the merits of Professor Weiss, and the originality of his own labours and publications, I believe I have sufficiently proved, that I have not, nay, that I could not possibly have, borrowed any thing from him; an inference which he draws from an assertion which he makes, without knowing the circumstances, which I had been the proper person to explain, had he but directly applied to me. And thus, I think, I have perfectly cleared myself

from the suspicion which he has thrown upon me, in your eyes, and in those of all who either may not have the opportunity, or the inclination, to compare his writings with mine, which would of itself be sufficient for my justification. But I invite Professor Weiss himself to undertake such a comparison; for, by his bold assertions of "inconvenience, impropriety," &c. he betrays a want of acquaintance with my method in general, which I should imagine a person ought to have previously acquired, who intended to lay before the public so comprehensive a critical examination of it, as he has assumed the appearance of doing. I am, Sir, your most obedient servant,

FREDERICK MOHS.

FREYBERG,
11*th January* 1823.

ART. IX.—*Account of the Cavern and Natural Glacier of the Rothorn, called the Schafloch or Sheep's Hole.* By M. DUFOUR, Lieutenant-Colonel of Engineers *.

HAVING learned, during my abode at Thun, that a cavern or natural ice-house, seldom visited even by the country people, and consequently very little known, existed in the side of a steep and rugged mountain called Rothorn, at a considerable distance from thence, I set out to visit it, accompanied by several officers, on Thursday September 5. 1822, the weather being remarkably fine, and Fahrenheit's thermometer from 73° to 77°.

We went by water from Thun to Merlingen, which occupied an hour and a half: here we engaged a guide to carry our provisions, as none could be had farther on; from thence we were two hours in reaching a cottage, which is the highest to be met with in ascending the Rothorn by the Wustenthal, or Deserted Valley. The road, cut out in some places in the edge of the beds of calcareous argil, which are here almost vertical, is very rapid, but nevertheless quite practicable. The direction of the valley is from south-west to north-east.

It is necessary to take several guides from the cottage, or at least to provide one's-self with a sufficient quantity of flambeaux, in order to be able to penetrate to the extremity of the cavern,

* Translated from the *Bibliotheque Universelle* October 1822, vol. xxi. p. 113.

which is called Schafloch or Sheep's Hole, because it affords an asylum to these animals from the burning heat of the sun, and when surprised by a storm. These mountaineers being only visited by a few hunters, are satisfied with a very trifling remuneration: four or five small pieces of money are to them a little treasure.

From the cottage to the cavern occupied us an hour, although in a direct line the distance seemed very short. The ascent is very steep (from 30° to 35°), and we were obliged to make use of our hands to assist us in climbing, especially at a place where we passed over the summit of a rock, with a precipice on each side. This bad step, which some people would not dare to attempt, is not in reality dangerous, if one preserves their presence of mind, and is accompanied by a guide: it is short, and after having passed it, we found ourselves above the pine forest, and at the foot of the perpendicular rocks, round which we ascended for a quarter of an hour, walking upon the steps formed by the strata.

These rocks are calcareous, and of a deep grey colour: they are mixed with clay, are in beds, from eight to twelve inches thick, in the direction of the valley, and dipping from 15° to 20° towards the west. The strata are cut by fissures perpendicular to them, and to the general plane of the slope, so that they present externally the appearance of a wall of tolerably regular rouble-work. The peaks of the mountains are crowned by a sandstone, containing a great many small particles of quartz, which seems to be placed there as a witness of the antient order of things. A great many fragments of this rock are to be found on the side of the mountain.

I had not been able to provide myself with a barometer sufficiently portable, consequently I could not ascertain the exact height of the grotto above the Lake of Thun; but by comparing the height of the Rothorn with that of the surrounding mountains, I fixed it at nearly two-thirds of the Niesen; that is to say, at about 3700 feet (5480 feet above the level of the sea). It is covered by a mass of rocks of 1000 or 1500 feet in thickness, the numerous fissures of which permit the water to pass through, and fall drop by drop into the interior of the cavern. This water, cooled by passing through the strata of air which

fill the fissures, and assisting by its own evaporation to maintain a very low temperature. reaches the cavern, and, falling upon masses already congealed, covers them with new layers: thus considerable quantities of ice are formed, which are only partly melted when a warmer air penetrates to the extremity of the grotto, which must be very rare indeed, if we may judge from what we ourselves experienced. In fact, notwithstanding the great heat we felt without, the thermometer, suspended at a foot from the ground, in different parts of the grotto, remained steady to 38°. Let us, however, proceed to the description of the Shafloch, which would undoubtedly have been considered by the antients as one of the principal gates of Tartarus, had it been known to them.

The opening is towards the east, opposite to the magnificent summits of the Jungfrau, the Eiger, and some of the other high Alps: it is regular, of a semielliptic form, the ground representing the large diameter, the length of which is fifty feet; the height of the vault at the entrance is only twenty-five feet, but it immediately increases to forty or fifty feet. We proceeded about fifty paces in the original direction from east to west: we afterwards turned to the south, descending amidst innumerable masses, which had detached themselves from the vault, and which render the way very dangerous, if care is not taken to light it well with flambeaux. It does not appear that these masses detach themselves from the vault at intervals. I rather think that these blocks are part of a stratum which has tumbled in a mass a great while ago. Prudence demands, however, that, before advancing, the state of the vault should be ascertained as nearly as possible, in order to avoid the danger which might be incurred by venturing under a rock which threatened to fall.

We met with the first mass of ice where the external light only penetrates in very small quantity, and where, of course, it is impossible to attribute it to the snow which might be driven in by the opening, when the winter wind blows in that direction. After proceeding a little farther, we found ice under foot, so transparent that we saw the rock through it which it covered. We proceeded for eight or ten minutes to the south, till we reached an inclined plane of ice, which, according to our guides,

had until now arrested the curious. In fact, it required a considerable degree of courage to allow one's-self to slip down this polished surface, even although the rock was distinctly visible which was to stop us, and the leap not very considerable. Beyond it, the cavern turned to the right, and descending below its former level, presented only a frightful darkness to those whose eyes endeavoured to penetrate its depth.

The officers, however, would not be stopped: we therefore, upon the faith of our guides, made the leap with the best grace we could, and descended from rock to rock, till we reached a flat part, covered with a layer of the purest ice, and hung on the right and left with large masses or stalagmites of congealed water, the surface of which appears to undergo a slight evaporation. We heard at regular intervals the noise of the drops of water falling from the roof into the little reservoirs they had hollowed for themselves in the ice below

This hall, vast and horrible, but magnificent, terminates the natural ice-house, much more remarkable for its grandeur as a cavern, than for the quantity of ice it contains. It required half an hour to reach the extremity of the cavern, because we were stopped at every step, either by the difficulty of the way, or the singularity of the spectacle; but its real depth cannot be less than 10 minutes. Its general form is exactly that of a Z; its dimensions are every where about 100 feet wide by 40 high, except at the external entrance, where it is not so high. The slope from the entrance to the extremity is considerable; but it is at the second elbow especially that it is steepest, and that the inclined plane of ice already mentioned is situate.

In coming out of the profound darkness in which we had been plunged for an hour, we found some difficulty in being able to support the light of the sun; but our eyes soon became accustomed to its brightness, and the landscape, which presented to us a smiling verdure, the limpid water of a beautiful lake and a serene sky, met at the horizon by the glittering summits of the Alps, seemed only the more enchanting.

It is better to return by the same road, than to attempt to follow a sort of path in the face of the rock which is on the right in coming out of the cavern: it finishes very soon, and leaves you in the midst of rocks and forests, which it is impossible to

get out of without great difficulty, and, I may add, not without some danger.

We very foolishly allowed ourselves to be tempted by a new path, and it was only after a slip, and more than one tumble, that we succeeded, after four or five hours of fatigue, in getting out from amongst the rocks, in order to descend to the village of Sigriswil, on the other side of the mountain. From thence to the little village of Gunten, where the boat was waiting for us, is only a short walk. We got into it, overcome with fatigue, and our clothes all torn; but delighted at having overcome all the difficulties of this little expedition.

Art. X.—*Gleanings of Natural History, gathered on the Coast of Scotland during a voyage in* 1821. By the Rev. John Fleming, D.D. F.R.S.E. M.W.S. &c. * In a Letter to Professor Jameson.

My Dear Sir,

The sketch which I gave you last autumn, of some of the observations which I made in the course of the voyage, in which I accompanied Mr Stevenson in the Regent Yacht, during his annual inspection of the Northern Light-houses, was so very short and imperfect, that I now willingly embrace the opportunity of complying with your wishes, in communicating the remarks in a more extended form. It is but lately, indeed, that I have had it in my power to examine the specimens which I collected, or to arrange the few notes which I took of the more interesting appearances which presented themselves. I must add, however, that the opportunities of landing at the different parts of the coast, though frequent, did not permit of any extended inquiries. Desultory observations only were attainable.

20th July.—Embarked in the evening at Newhaven, and bore away for the mouth of the Firth of Forth. The weather was at this time fine, with the wind blowing slightly from the SW. In passing Inchkeith, however, the motion of the sea was observed to be irregular; and by the time we reached the

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* Read before the Wernerian Natural History Society, 14th Dec. 1822.

Bell Rock on the following morning, a considerable swell from the SE. prevailed. Having landed on the Bell Rock, and spent some time in surveying the arrangements of the light-house, a minute account of the details of which may shortly be expected from the pen of the able engineer by whom they were framed, a few minutes only could be spared for the pursuits of natural history on the rock itself. This last, in a mineralogical point of view, presents nothing of interest. It is a portion of the great bed of *old red sandstone*, of which the rocky promontory called the Redhead, on the neighbouring coast of Angus, consists; the characters of which I have given in considerable detail, in the second volume of the Memoirs of the Wernerian Natural History Society.

In the numerous pools of water left by the retiring tide, the *Aplysia depilans*, an animal celebrated in the annals of superstition, occurs in great abundance. The *Doris argo*, *Eolida papillosa*, and *Corypna glandulosa*, were likewise common. These four species, I may add, are plentifully distributed in the Isle of May. The *Tubularia penicillus* of Muller (Zool. Dan. lxxxix. Fig. 1. 2.), was likewise observed.

The bottom and sides of almost all the pools were densely clothed with the Fucus lycopodioides of Turner, Historia Fucorum, p. 24. tab. xii. It was here growing directly upon the rocks; and not, as in many other places, parasitic on the stems of the larger fuci. This plant is the favourite residence of the smaller marine animals. A few tufts which were pulled up, yielded us the *Helix margarita*, and *Turbo striatus* of Montagu, in great abundance; together with *Oniscus marinus* of Pennant (Idotea entomon var. of Latreille), and *Idotea pelagica* of Leach, (probably the Oniscus marinus of Linnæus). Besides these, the two following species of less frequent occurrence presented themselves.

1. Cyclops chelifer of Muller's Entomostraca, p. 114. Tab. xix. Fig. 1. 3. This species differs so much from the *Cyclops quadricornis*, the well known type of the genus, as to render the institution of a new category necessary for its reception, which may be termed *Dactylops*. It agrees, indeed, with the genus *Calanus* of Dr Leach (Supplement to the Encyclopædia Britannica, article Annulosa), represented by the *Cyclops*

longicornis of Muller (Ent. p. 115. Tab. xix. Fig. 7. 9.), in possessing only two tentacula; but it differs very remarkably in the pair of triarticulated cheliferous hands, and the pair of unguiculated feet which follow.

2. Proto pedatus.—This is the *Gammarus pedatus* of Müller (Zool. Dan. Tab. ci. Fig. 1. 2.), and the *Cancer gammarus pedatus* of Montagu, (Lin. Trans. vol. xi. p. 6. t. 11. f. 6). The four minute appendiculæ at the extremity of the posterior end, which are figured by Müller, but which Montagu was unable to detect in his specimens, were readily distinguishable in the one which occurred here.

The genus *Proto* was instituted by Dr Leach in the article Annulosa, already referred to. It has been adopted by M. Latreille, in the "Regne Animal" of M. Cuvier, vol. iii. p. 52., with the following character: "Ont dix pieds, disposés dans une série continue, depuis la tète jusqu'au quatrième anneau inclusivement." It is true that there are only ten feet, if we exclude the two pairs belonging to the first and last segments of the body; but if these be included, the number of feet should be stated at fourteen. This precision in enumerating the feet becomes the more necessary, since Latreille has added another genus, termed *Leptomera*, to the family Caprelladæ, which, in the character assigned to it, "Ont quatorze pieds, disposés dans une série continue, depuis la téte jusqu'à l'extremitie posterièure du corps," (Ib. p. 51.), would appear to differ only in having four additional feet. But the *Squilla ventricosa* of Müller (Zool. Dan. tab. 56.), referred to as the type of the genus Leptomera, possesses the same number of feet as the *Gammarus pedatus* of the same author, referred to as the type of the genus Proto. The feet of the first and last segments of the body, however, have been enumerated by Latreille, in the character of his genus Leptomera, while they have been excluded from the character of the genus Proto. The two genera, in consequence of this management, *seem* to differ in a character in which they agree. M. Lamarck, aware of this agreement, included both under one genus, to which, however, he gave, unnecessarily, a range of character "dix ou quatorze pattes" (Animaux sans Vertebres, v. p. 172.), and improperly gave the preference to the generic name Leptomera, devised by his coun-

tryman, instead of employing the term of our English naturalist, which had been first established. There is, however, no necessity for the extinction of either genus, as there are characters peculiar to each of the species which have been regarded as types, overlooked by both Latreille and Lamarck. In the Leptomera, the tarsi of the second pair of feet only are furnished with a moveable claw; while in Proto, all the feet are unguiculated. In the latter genus, the second, third, and fourth pairs of feet have appendages at the base, which are wanting in Leptomera. We are not aware that the *Leptomera ventricosa* has ever been detected on the British shores.

In the Caprella, the other genus of the family to which Proto and Leptomera belong, there is only one species which has been distinctly ascertained as an inhabitant of our seas, viz. *Cancer Phasma* of Montagu (Lin. Trans. vii. p. 66. Tab. vi. Fig. 3.), which he observed on the south coast of Devonshire. In 1817 I found it at the Isle of May. It is subject to considerable variation in the number and position of the spines, and the hairiness of the different parts. In the example now before us, the claw and last joint of the first pair of feet were deeply serrated. It is probable that the *Caprella Pennantii*, and *acanthifera* of Dr Leach (Edin. Encyclopædia, vol. vii. p. 404.), are merely varieties of this species. In the bottom of a pool I observed the beautiful *Planaria atomata* of Müller (Zool. Dan. xxxii. Fig. 3, 4.), a species which I had previously noticed in August 1814 at Aberbrothick, on the neighbouring coast. This species, together with *Planaria tremellaris* of Müller (Zool. Dan. Tab. xxxii. Fig. 1- 2.), and *P. vittata* of Montagu (Lin. Trans. xi. p. 25. Tab. v. Fig. 3.), form a curious group of marine Planariæ, distinguished by their shape, and the number and position of the eyes.

Having returned from the Bell Rock to the vessel, the course of which was now directed to Aberdeen Bay, which was reached in the evening, I devoted some time to the examination of the molluscous cargo which I had brought on board. While observing the motions of some of the animals in a glass of seawater, a medusa presented itself belonging to the genus Geryonia of Peron and Lesueur. The body was diaphanous, round at the margin, subconical, blunt at the summit, and slightly acu-

minated. The central mouth was trumpet-shaped, and shortly pedunculated. The circumference of the body was furnished with eight similar tentacula, equal to its diameter. As it differs from *Geryonia dinema* and *proboscidalis*, the only known species, I have named it *G. octona*.

During the fore part of night there was little or no wind; but early on the morning of the 22d, the wind began to blow from the SE. with rain, and continued during the whole day a stiff breeze, which, after we had touched at Frasersburgh, carried us on the morning of the 23d into Bressay Sound, Zetland. I mention the occurrence of this breeze from the SE., in consequence of its approach having been announced to us on the evening of the 20th, in the Firth of Forth, on the forenoon of the 21st at the Bell Rock, and as indicating a condition in the Natural History of winds, well known to sailors, but which has hitherto been in a great measure overlooked by the meteorologist.

On the 27th we sailed from Bressay Sound for Sumburgh Head, where a light-house has been recently erected. In the boats from the distant cod-fishing, several of the rarer deep-sea *vermes* were observed, none of which, however, were new to us as Zetlandic productions, except the *Cymothoa æstrum*. In the immediate neighbourhood of the boats, when the fish had been *cleaned*, the contents of their stomachs were lying on the beach. These consisted almost exclusively of the *Asterias aculeata* of Müller (Zool. Dan. Tab. xcix.), sparingly intermixed with the *Asterias fragilis* of the same author. The first of these species, *A. aculeata*, I had an opportunity of adding to the British Fauna in 1809, having procured it by dredging in Bressay Sound. It is probably confined to the shores of Scotland; at least it was regarded as a new British species by Col. Montagu, to whom I sent specimens in 1810, and who had paid particular attention to the tribe Stelleridæ. I have likewise found it at Kirkcaldy in the Frith of Forth, and at St Andrew's. The other species, Asterias fragilis, which is subject to some variation of colour, but especially of form, depending on its state of repletion, has been multiplied by Pennant, from the imperfect representations of Borlase, chiefly into the following species: *A. sphæ-*

rulata, pentaphylla varia, aculeata, hastata, fissa and *nigra.* (Brit. Zool. vol. iv. p. 64.)

The *Brachyrhinus clavipes* of Latreille (Curculio niger of Marsham), was here observed on the sand-hills in considerable abundance.

Taking our leave of Zetland, we reached the Start-point in Sanda, Orkney, on the morning of the 28th. Upon landing, I hastened to the small lake in the neighbourhood of the light-house, where, thirteen years before, I had observed the *Lobipes hyperboreus* or Red Phalarope. The lake was now, however, dried up; and deep rents in its massy bed indicated the extreme drought of the season. In the evening we came to anchor in Kirkwall Bay.

In visiting a small collection of the birds of Orkney, in the possession of Mr James Scarth, the specimens of the red-throated and black-throated divers constituted the most interesting objects. Mr Scarth assured me that they were shot in Widewall Bay, South Ronaldshay, in the month of February preceding, swimming in company, while no other birds of the same kind were to be seen in the bay. This occurrence appears to give considerable support to the opinion that these two birds belong to one species, especially when viewed in connection with an observation which I made in 1808. Arriving unobserved at the margin of a small lake, in the unfrequented muirs to the north of Ronas Hill, in Zetland, I perceived a red-throated and black-throated diver swimming in company, and having under their charge a young bird. They instantly shewed symptoms of anxiety. Upon firing, the young bird was killed, and the red-throated diver was so much wounded as to prevent its flight. The black-throated diver suddenly plunged under water, came to the surface again at a little distance, and took flight, having escaped unhurt. I could, however, distinctly perceive the black-throat, as indeed I had done at the first. I now exerted myself to secure the wounded bird, in which I succeeded, after several ineffectual efforts, the bird always diving, and avoiding the shot. This bird proved, on dissection, to be a female, and I inferred that the black-throated bird which escaped was the male. Having stated the conclusion to which I was thus led, in a letter to Mr Montagu, he published an extract therefrom in the Sup-

plement to his Ornithological Dictionary (Exeter, 1813), article Diver—Red-throated, with the following remarks: "Experience has shewn that some birds vary in plumage so much, at different seasons, that species have been continually multiplied from this circumstance alone, but, in this instance, we are still inclined to believe these birds are really distinct. The black-throated diver has been described by most naturalists as a distinct species, and appears to have been particularly noticed as an inhabitant of the arctic regions, where they breed, and afterwards retire. It must, however, be admitted, that the black-throated diver is extremely rare on the coast of Britain; a circumstance that must favour the opinion, that the black on the throat may vanish after the breeding season, and be substituted by the ferruginous feathers which characterise the red-throated species. But it must also be remembered that this is not the only distinguishing mark, for if we attend to the descriptions of the two birds, there is a material difference in other parts of the plumage. It may, however, be urged, that these are as likely to change with the season as the feathers on the throat. We have given these hints as the result of the observations of a correct naturalist, in order to stimulate those who may have the means of clearly ascertaining the fact not to lose the opportunity. One of the principal objects of inquiry appears to be this: has the black throated diver been observed in winter?" Great confusion, indeed, prevails in the characters of the species of the restricted genus Colymbus, which the more recent writers on ornithology have failed to remove. M. Cuvier, in his "Regne Animal," i. p. 508., unites under one species—"Le grand Plongion," the *Colymbus glacialis*, *arcticus*, and *immer*; and under another, "Le petit Plongion," the *Colymbus septentrionalis* and *stellatus*. M. Temminck, in his very valuable "Manuel d'Ornithologie," (Paris, 1820), ii. p. 910., agrees with Cuvier, in adding the *C. immer* to *glacialis*, and *C. stellatus* to *septentrionalis*, but he preserves the *C. arcticus* as a distinct species. It is probable, however, that while *C. glacialis* includes the *immer* as the young, and *C. arcticus* includes the *septentrionalis* as the female, the *C. stellatus* is entitled to rank as a separate species. The superior strength of the bill, its horn-colour, and the shortness of its lower mandible, sufficiently

distinguish it from the latter, while the absence of the sharp dorsal ridge on the middle of the upper mandible, immediately above the nostrils, indicate it to be different from the former.

By means of a grapple, some fuci, with adhering animals, were procured from the bottom of the bay. The *Millepora polymorpha* appeared in such abundance, as to warrant the conclusion, that it might be advantageously employed for the purposes of agriculture and building, especially as limestone in Orkney is scarce, and generally of bad quality, some of it containing 20, and even 30 per cent. of impurities.

One example of the *Asterias nigra* of Müller (Zoologia Danica, tab. xciii. f. 1, 2, 3.), was procured, making another addition to the British Asteriadæ from the Northern Seas.

The following animals of the Linnean genus Ascidia likewise occurred :—1. *Clavelina* (Savigny) *lepadiformis*, (Zool. Dan. tab. lxxix., f. 5.). This was first recorded as British, in consequence of specimens being sent by Dr Leach to M. Savigny, and noticed in the "Memoires sur les Ascidies" (Paris, 1816), p. 237. 2. *Ciona intestinalis*, the Ascidia corrugata of Müller (Zool. Dan. lxxix., f. 3, 4.), which I had observed many years before as a common Zetlandic production. 3. *Pandocia conchilega*, (Zool. Dan. tab. xxxiv., f. 4, 5, 6.). It was, as usual, much infested with the Modiolus discors.

The *Botryllus Schlosseri* was likewise abundant, covering the roots and stems of the larger fuci, and, like the preceding, inclosing numerous specimens of the Modiolus discors.

Not a few examples of the Aplysia depilans were brought up, and along with these a solitary specimen of the *A. punctata* of Cuvier. It was a young one, not exceeding an inch in length On the Devonshire coast, as I have been informed by Montagu, it is found so large "as to fill a moderate sized tea-cup." The white spots, by which this kind is characterised (for the condition of the branchial lid is the same as in A. depilans), are far from sufficient to justify its claim to rank as a distinct species, especially as the common kind is subject to considerable variation of colour. It is singular, however, that, while numerous examples of the latter have occurred to us on different parts of the coast, this is the first time we have met with the one having white spots.

Leaving Kirkwall Bay, we reached the Pentland Skerries in the forenoon of the 1st of August, and came to anchor in the Bay of Wick in the evening. At this place, very extensive improvements have been effected in connection with the Herring Fisheries. The south side of the bay has recently been ornamented with a new town of handsome houses. The neighbouring fields, at this time, exhibited crops much more luxuriant than any which we witnessed in the course of the season. This fertility of the soil (naturally poor, being a mixture of peat and sand, resting on sandstone), has been produced by the application of a *compost*, formed from fish-garbage, the refuse of the herring-curers, with peat-moss or soil. Ground which we witnessed, in the year 1810, producing only stunted heath, with many bare patches supporting a few dwarfish plants of the *Primula farinosa*, or the more humble *Bæomyces roseus*, now supported crops of oats, which, even in spite of the dry season, were of the freshest colour. The garbage, however, at that period, was in a great measure neglected. We mention this change, which has been produced at Wick by the application of this efficient manure, for the purpose of exciting the proprietors and farmers in Zetland, Orkney and the Hebrides, to avail themselves of a source of fertilising manure, which they have too long inconsiderately overlooked. Indeed, at all the stations where fish are cured, materials for the formation of a productive compost may be procured in plenty. At Sumburgh we saw a quantity of garbage left to be washed away with the tide, which, with proper management, might have served to fertilise an acre of ground.

In going into Thurso Bay, on the morning of the 3d, a Medusa, probably belonging to the genus Eulimena of Peron, appeared to be abundant. It was transparent, about half an inch in breadth, by about one inch in length. The extremity at the mouth was truncated, the opposite one rounded. Eight minutely ciliated ribs proceeded from the crown to the disk of the mouth. This disk was smooth, having the mouth in the form of a narrow transverse slit, leading into an apparently simple cavity in the interior. When active, the ciliæ of the ribs were constantly in motion, and the body frequently assumed the form

of a quadrangular prism; hence, if it be an undescribed species, which it probably is, it may be denominated *E. quadrangularis.*

On the 4th we left Stromness, which we had reached the preceding evening, for the purpose of visiting the curious sandstone rocks at Yestnaby, near to Skail. The strata have an inconsiderable dip, and consist of thin slaty sandstone, abounding with argillaceous and ferruginous matter, with minute scales of mica. The uppermost layer (or even layers), when exposed to the action of the atmosphere, aided occasionally by the spray of the sea, becomes divided into numerous tabular pieces, by means of vertical rents, and exhibits the appearance of Mosaic work. These tables are angular, but differ in the number and relation of their angles, although they sometimes exhibit regular geometrical forms. Upon the layer being thus divided, decomposition speedily takes place. It proceeds from the sides towards the middle, and as the decomposed matter is washed off, the table exhibits a depressed border, marking the extent of the decay, having the middle raised, and consisting of fresh matter. In some cases there is a well marked groove separating the two portions. In both species there are prominent irregular pieces of the rock, which seem little liable to decomposition. In the sandstone in the neighbourhood, there are a few inconsiderable beds of thin slaty limestone, much impregnated with bitumen and pyrites.

While again entering the Pentland Firth, and at the mouth of Longhope, a whale remained a considerable time in the neighbourhood of the vessel. It came to the surface several times, at a short distance, and enabled us, by perceiving the fin upon its back, its plaited breast, and pointed head, to identify it as the *Balænoptera rostrata.*

(*To be continued.*)

Art. XI.—*On the order of the Appearance and Progress of the Aurora Borealis.* By the Reverend James Farquharson, Alford. (Communicated by the Author.)

The Aurora Borealis is very frequently visible in Aberdeenshire. I have had opportunities for observing it a very great

number of times; and have remarked a certain order in its appearance and progress, which it is the object of this paper to describe. The subject acquires interest from its evident connection with the new science of electro-magnetism.

In this latitude (about 57° 12′ N.), the aurora borealis, on those nights when it is visible, generally first shows itself after dark, like a bright but circumscribed twilight, on the visible horizon *, the centre of which is exactly on the northern point of the magnetic meridian. So long as the bright space continues low, its light resembles nearly the pale blue-white light of the real twilight, but varies momentarily in intensity, by incessant and undefined fits of gleaming and obscuration.

By degrees the meteor enlarges itself, rising higher, and extending more from east to west on the horizon. The play of the fitful gleaming light becomes gradually better defined, and the whole luminous space presents the appearance of pencils or bundles of rays, pointing upwards, and, when viewed in narrow compartments, maintaining a parallelism among themselves, similar to that exhibited by the rays of the sun, when he shines through broken clouds, athwart a hazy atmosphere. The rays, which are on the magnetic meridian, are parallel to that line, pointing exactly to the zenith; and those which are considerably to the eastward or westward of that meridian, are directed to the zenith, or to a point which appears within the limits of 10° to the southward of it.

The bluish-white light changes into a beautiful pale green, which, when the meteor rises quite above the horizon, as will be afterwards described, becomes tinged at the lower extremity of the pencils of rays, with blue and violet, and at their upper extremity with yellow and orange. The rays are very various in their intensity of light, as compared with one another; their higher and lower portions also frequently differ from each other in that respect; and the whole appearance of each ray varies incessantly. It now breaks of, and disappears for a considerable space at its higher or lower extremity, and then immediately becomes again luminous

* The observations have been made in a valley, surrounded on all sides by hills from 500 to 1000 feet high, and from two to five miles distant from the place of observation.

to its former extent; now runs from east to west, or from west to east, through 5° or 10° or 12°, during the space of a second or two of time, preserving correctly its parallelism with other rays, which it approaches or passes in its progress, then remains stationary for a second or two, undergoing varies changes of vividness; and afterwards disappears instantaneously, to have its place supplied by another ray, created as rapidly as its predecessor was annihilated.

This magnificent and beautiful light gradually extends itself towards the south, and at length separates itself from the northern horizon, at the point of the magnetic meridan, and forms a flat luminous arch in the northern part of the heavens. The arch still goes on to make progress towards the south; its convex or upper side approaching the zenith, and its concave or lower side becoming more widely separated from the horizon. When it reaches an elevation of about 45°, it presents the appearance of a broad zone, occupying, from north to south, the space of from 25° to 35° in breadth, at its vertex; and having its eastern and western extremities resting on the visible horizon; and at this stage of its progress the eastern extremity is near the NE. point of the compass, and the western extremity a little to the north of west. At its extremities the zone is narrower than at its vertex; and when I speak of its being from 25° to 35° wide there, it is not meant that its northern or southern boundaries are correctly defined, but only that the pencils of rays, when most elongated, do not extend beyond that space. As the rays shorten and lengthen, and flit and change places incessantly, the boundaries of the luminous space are very much indented and irregular, both towards the north and towards the south.

The illuminated zone in its progress southward preserves a parallelism with its earlier positions; and, after passing the elevation of 45°, at its vertex, begins to undergo a remarkable change in its appearance. The pencils of shifting and varying rays, which, till then, occupied, in the direction of their length, a space of from 25° to 35°, become gradually more and more shortened, as the zone approaches the zenith, and the limits of the indentation and irregularity of the southern and northern boundaries of the luminous space become less. The belt of light becomes

gradually more compact, and its vividness greater. The pencils of rays upon the magnetic meridian, still continue directed towards the zenith, and those considerably to the eastward or westward of that line are still directed either to the zenith, or to a point a little southward of it; and, therefore, changes gradually the angle which they make with the zone. At the same time, both the eastern and western extremities of the arch generally becomes gradually elevated above the visible horizon; a circumstance which frequently takes place, with regard to one or both of them, at an earlier stage of the progress southward.

At length the luminous zone reaches the zenith, and coincides in its whole extent, from east to west, with the Prime Vertical, to the magnetic meridian; and the changes described in the last paragraph having gone on continuously, it now presents an appearance which deserves a particular description. It is very narrow, in comparison with what it was when in the earlier stages of its progress, not exceeding in breadth from north to south more than 3° or 4°, or at the most in its widest parts 5°. It has its boundaries better defined both to the south and north; for it now vanishes off entirely from its compactest central light, within the limits of 1°. The intensity of the light is now greatly increased, and, near the zenith, the light no longer shews parallel rays, but exhibits a nebulous or mottled appearance, varying incessantly in intensity, by tremulous flickerings, in undefined small patches. Towards the east and west of the zenith, the light assumes a mixed character, partaking of the nebulous appearance, and of the appearance of parallel rays; the latter gradually prevailing in proportion to the distance from the zenith, and becoming perfect towards the extremities of the zone; and as the rays still point towards the zenith, or a little southward of it, they are now parallel, or nearly so, to the line of the zone. At this period both extremities are generally elevated above the horizon, sometimes 25° or 30°, sometimes more. Sometimes one of them is very little elevated, not more perhaps than 5° or 10°, and the other extends very little beyond the zenith, for in this respect the zone is exceedingly various.

The luminous space still continues to move southwards, preserving its parallelism with its earlier positions; and, after it has reached 5° or 10° to the southward of the zenith, it begins to

enlarge in width, by a change exactly the reverse of that by which it had become narrower in its progress towards that point. The light near the vertex of the arch again assumes the appearance of pencils of rays, parallel to the magnetic meridian; and the rays near its eastern and western extremities no longer maintain their parallelism with the line of the zone, but again form an angle with it, which gradually increases as the zone gets farther south; for they still direct themselves towards the zenith, or a point within the limits of 10° to the southward of it. This enlargement and gradual change of appearance of the luminous space have always gone on continuously, so long as it has been visible in its progress towards the south. But in the observations which I have yet made, the meteor never reached above 25° or 30° to the southward of the zenith; having become gradually indistinct, and having vanished entirely before passing that limit. I have, indeed, seen the meteor near the southern horizon; but it is of extremely rare occurrence in that quarter; and I cannot say whether, in any case of that description, it had travelled from the north; never having observed any of them sufficiently early, to be able to determine that point. I can only say that the bundles of rays are vertical, or nearly so, in the south, as they are in the north.

Such is the order of appearances presented by the aurora borealis, when it has been observed under the most favourable circumstances. It is very seldom, however, that all the successive phenomena now described have been observed continuously on the same evening; but those observed at any one particular time, have always been entirely consistent with the above description; and I shall now enter a little into a detail of the varieties which present themselves.

It very frequently happens that the twilight appearance on the northern horizon is all that is visible; and the phenomenon begins and ends with that. In this case, the meteor is seldom of long continuance; but, during the time that it lasts, the luminous space gradually enlarges itself towards the south. It then gradually disappears, frequently, to be succeeded by another, appearing low on the horizon, to enlarge, and afterwards disappear, as its predecessor had done.

It happens also very frequently that the meteor, even when

it makes more progress towards the south, becomes gradually extinct, long before it reaches the zenith, for it is liable to a total extinction in every stage of its advancement; but while it does continue, it follows the order above described, presenting the longest pencils of rays when at or below 45° of elevation, and more dense, compact and shorter ones, when nearer the zenith.

It also very frequently happens, that the meteor is suddenly formed high above the horizon, at first by feeble detached rays, becoming quickly more compact and luminous. But, in whatever stage it first begins, the succeeding relative progress is the same as above described. It was chiefly those meteors which were first formed above the horizon, that were observed to pass over the zenith. Those formed farther northward, generally disappeared before reaching that point.

There is another modification of these appearances, and that is, when the whole meteor is either entirely to the eastward or westward of the magnetic meridian; and this is of not unfrequent occurrence. In this case, the appearance and progress of the whole exactly agree with those of corresponding portions of the above described zone, which is formed when the meteor extends across the magnetic meridian. The extremity of the luminous space, which is nearest to the magnetic meridian, becomes first elevated above the horizon; the pencils of rays are directed longitudinally towards the zenith, or a point a little to the south of it; and the meteor moves gradually towards the south, contracting gradually, in its lateral dimensions, till it reaches the prime vertical to the magnetic meridian, where it assumes the appearance of a vertical column of brilliant light, 3° or 4° in diameter, composed of pencils of rays parallel with itself. After passing the prime vertical to the magnetic meridian, or from 5° or 10° to the southward of it, the meteor begins to enlarge gradually in width, in an order the reverse of that in which it had become narrowed.

Some other apparent irregularities have been at times observed. Thus, the pencils of rays have sometimes been seen separated into detached groups, but each group has been consistent in its appearance and position with those of the other groups; so that, had the spaces between them been filled up, a complete zone, such as above described, would have been

formed. A detachment into separate groups sometimes takes place immediately previous to the disappearance of the meteor; but sometimes, also, it is not immediately followed by that disappearance, but the zone becomes again complete, or nearly so, at a farther stage of its progress southward.

But no anomalies have at any time been observed: nothing that is inconsistent with the described order of the phenomena. Thus, in whatever part of the heavens the pencils of rays have made their appearance, they have never been seen not directed to the zenith, or a point a little southward of it; the zones of light have never been seen moving northward, or quite stationary; comparatively short pencils of rays may be mingled occasionally with long ones, at or under 45° elevation, on account of their frequently breaking short, but no long pencils of rays have been observed near the zenith; and at the zenith no parallel rays have at any time been seen, but only the narrow belt of nebulous light.

It is quite evident, that the only conditions that can explain and reconcile all these appearances, are, that the pencils of rays of the aurora borealis are vertical, or nearly so, and form a deep fringe, which stretches a great way from east to west, at right angles to the magnetic meridian, but which is of no great thickness from north to south; and that the fringe moves southward, preserving its direction at right angles to the magnetic meridian.

In regard to the velocity with which the meteor moves towards the south, that is exceedingly various. It was once seen to pass in the space of half an hour from 45° N. of the zenith, where it was first observed, to 30° S. of that point, where it became extinct. Its light, in that instance, was uncommonly vivid. At other times the meteor has been seen to move comparatively so slowly, that its motion could only be discovered by an observation continued for some considerable time. Its light in these cases was faint; so that the intensity of the light appears connected with the rapidity of the progress southward.

The meteor occurs when the atmosphere is quite clear, as well as when it is partially obscured by clouds; and, even when a compact fleece of clouds covers the whole heavens, its existence in the higher regions is frequently ascertained by the re-

flection of its peculiar fitful light. It precedes or accompanies westerly or south-easterly gales.

A question arises concerning the height of the aurora borealis above the surface of the earth. To that question I can give only a conjectural answer, arising out of one singular phenomenon which I had occasion to observe last winter.

During the continuance of a pleasant south-westerly gale, of mild temperature, the atmosphere, which had been cloudy through the day, became quite clear about sunset; and, after dark, a pale aurora borealis appeared in the north, which I was observing at short intervals. Its lower or north edge had become elevated about 20° above the visible horizon at the magnetic meridian, when a solitary cloud appeared under it near that point, making its way rapidly from the west. It soon became evident that the meteor was affected by this cloud in a very remarkable manner. The lower extremity of the pencils of rays of the aurora borealis, appeared in contact with the upper part of the cloud, and the light of those pencils of rays directly over the cloud became very vivid, in comparison with those which the cloud had not yet reached. At the same time, the upper edges of the cloud itself became phosphorescent, exhibiting a denser and whiter light than could have been occasioned by any reflection of the greenish rays above it; while behind, in the space which the cloud had passed through, the aurora borealis became quite extinct. These singular appearances accompanied the cloud, while it passed from about NNW. to NNE; when the aurora borealis, having apparently passed to the southward of the cloud's path, was no longer affected by it; and the eastern portion of it continued visible for a considerable time; whereas the part which had been influenced by the cloud no more appeared.

From this instance, it would seem that the region of the aurora borealis is above, and immediately contiguous to that in which the clouds are forming, at the time of its appearance.

It would seem, also, from the above detail, that this latitude is near the extreme limits of the ordinary extension of the meteor towards the south.

February 3. 1823.

Art. XII.—*Journal of a Tour to the Coast of the Adriatic Sea, and to the Mountains of Carniola, Carinthia, Tyrol, Saltzburg, and Bohemia, undertaken chiefly with a view to the Botany and Entomology of those countries.* By Dr David Henry Hoppe and Dr Henry Hornschuch. (Continued from page 149.)

"*Hundsberg, Feb. 27.*—We have spent the greater part of the day in this city (Trieste), in order to take a view of its splendours, although but superficially, and to see the Carnival. We are disposed to consider, without any reference to its natural productions, that Trieste itself is well worth being visited by strangers. A sea-port, particularly an Italian one, possesses many attractions above inland towns. The beauty and riches of its valuable goods, which are every where exposed to public sale in the shops; the market, with its variety of articles, especially its Italian fruits, amongst which oranges and lemons are seen in all directions, piled in heaps like pyramids; the number of girls, offering the loveliest bouquets of flowers for a mere trifle; and, lastly, the crowds of people, among whom are seen individuals of all nations, distinguished by their physiognomy, no less than by their dress, are some of the first peculiarities that attract the notice of a stranger. The Carnival was, to us, quite a novel sight; more than a hundred carriages were, for hours, driving in a compact body through the principal streets of the city, to the Corso.

"When, again, you take a view of the ocean, which daily wafts intelligence from the most distant countries, which affords such a delightful opportunity for visiting foreign climes, which supplies the table with the rarest and most delicate fish, and brings the richest wines from other countries, it may easily be supposed, that every one here can have his wishes abundantly gratified, be his condition in life what it may. But, on the other hand, when we come to inspect more closely the real state of things, we shall find that "it is not all gold that glitters;" and that, in many respects, it is happier to dwell in our cold northern Germany than here. We will, however, spare our criticisms, as we come not to spy out the nakedness of the land, but to search for the productions which nature hither yields."

"*Hundsberg, March* 1.—Before we started from Gefrees, we thought with pleasure on the observations of Schwaegrichen, concerning the delightful spring of Trieste; and we then resolved that our first botanical excursion from that city should take place on the 1st day of March. In pursuance of this plan, we agreed to visit to-day the country of Contobello, in order to gather the *Euphorbia Characias*, which we have already mentioned as being so enthusiastically described by Baron von Wulfen. We had the additional inducement of believing that our friend Funck would, mentally, accompany us in this expedition.

"At eight o'clock in the morning, therefore, we hastened from our lodging at Hundsberg, towards Trieste; sufficiently provided with apparatus, both botanical and entomological, for securing all that we might collect. We quitted the city by the Contrade del Ponte, and gained the hills, which, on the right hand, bound the new Lazaretto. The sky was clear and serene, the air warm, the Karschgeburge Mountain extended far away to the right hand, the Adriatic Sea lay on the left. The road, however, was for a long way enclosed with high walls, as protection to the vineyards on each side, and upon these we sought in vain for mosses, particularly for the rare *Trichostomum latifolium*, in reality an alpine moss, and which surely can hardly grow, as it has been stated to do, "on walls at Trieste *." These walls, indeed, generally studded with pieces of broken glass stuck into the mortar at top, to prevent depredators from climbing over, had nothing growing upon them but dry bushes of roses and brambles, and a few patches of ivy.

"After we had walked for a good half hour, pent up between the walls, we got into a more open country, where a narrow path soon led us down to the sea-shore. On both sides of us, in the descent, grew bushes of *Wild Figs* (*Ficus Carica*) and of *Lavender* (*Lavandula officinalis*), just as brambles do with us. Before us lay the sea, which we approached in eager anticipation of the treasures we should find; but, behold, the beach was covered with rejectamenta for a foot deep, destroying all vege-

* Our excellent friend, Dr Schwaegrichen, the able Professor of Nat. Hist. at Leipzig, who is the authority for this, and whose society we have the pleasure to enjoy at the time these sheets are going to press, assures us that he gathered the plant plentifully in that spot.—Ed.

tation, and rendering walking very difficult and disagreeable. After a short space, the road again ascends to Contobello, which may be at about the distance of an Italian mile; but as the novelty of the sea-shore rendered it more attractive for us, we left the path, and proceeded for an hour longer on the pebbly beach, till our progress was arrested by the hills (covered with vines and olive trees), whose rocky fronts projected into the sea. It was near mid-day, and our boxes were filled with plants. This circumstance was chiefly owing to a quantity of branches, which had been cut down, bearing evergreen leaves, which resembled those of *Ilex aquifolium*, but belonging, in fact, to an unknown *Oak*. We know not how they came hither, whether they had been hewn down on the mountains, or brought hither by the sea. Let it suffice to observe, that all the leaves were thickly covered with a dark-brown *Erineum*, of which we collected the best specimens. Here we parted, and while one ascended the hills, the other gathered some interesting marine plants on the beach; among these were *Fucus spiralis*, *Esper*; *F. catenatus*, *Linn.*, and some *Ceramia*, which covered the stones that were lying in the water, and which, after being wafted from place to place by the inconstant waves, were at last destined to drop into our vascula. It was on this spot that the immortal Wulfen collected the *Algæ aquaticæ*, which he has described in so masterly a manner *, and we were not a little vain of being able to tread in his footsteps.

"Many *Ceramia*, and many molluscous animals, were left by us ungathered, in the hope of coming for them at a future time. The other of us obtained, under a wet rock entwined with ivy, the graceful *Venus-hair Fern* (*Adiantum capillus Veneris*), and *Dicranum pellucidum*. This was all the fresh vegetation that the hill afforded. Every where, indeed, were the withered

* Under the title of *Xaveri de Wulfen Abbatis Klagenfurthensis Cryptogama aquatica.* This excellent man was no less esteemed for his amiable virtues, than for his botanical acquirements. In 1762 he was appointed Professor of Natural Philosophy at Klagenfurth, in Carniola, where, besides attending much and strictly to his ecclesiastical and professional duties, he devoted a considerable portion of his time to mineralogy, and to describing the new and rare plants of that country and Carinthia, which forms an important portion of the *Flora Austriaca* of Jacquin, to whom he communicated all his discoveries. He died in 1806, and is reported to have left a complete *Flora Norica* (a district of Carniola), and an *Agrostographia*, neither of which, we believe, has been published.—Ed.

remnants of perennial plants and bushes; among which, we only recognised *Spartium junceum*, and *Scirpus romanus*: the others were unknown to us, and were principally individuals belonging to the 14th, 17th, and 19th classes, chiefly *Centaureæ* and *Artemisiæ*. We now ascended another part of the mountain, and climbing over walls, and through vineyards, which formerly yielded the precious Proseko, the favourite drink of Pliny, we came to Contobello, where we rested a while. In the crevice of the wall of a vineyard, we gathered *Ceterach officinarum*, and *Asplenium Adiantum-nigrum*, and, in grassy places, the first Violet of March, but we did not see the *Euphorbia*. We descended the steep footpath on the insulated hill of Contobello, and came to the stony road that leads to the city. Here we cast an anxious look on the left hand, over the vineyards, towards a group of rocks, which form the back-ground looking towards the sea. "Here," said one of us, "here, surely, must be the Euphorbia;" and there it was; all parts of the rock were full of it. It is, however, still backward in its flowers, and it may yet be a fortnight before the plants will be sufficiently advanced to be gathered. We reached Hundsberg late in the evening, and considered our reward sufficient to tempt us to future excursions."

"*Hundsberg, March* 2.—To-day we went into the city to visit the fish-market of Trieste, with our friend M. Hohl, as we had agreed to do, with the view of purchasing shells. It afforded many marine animals, and various kinds of fish, most of them unknown to us. Eels, shrimps, lobsters, cuttle-fish, star-fish, sea-urchins (*See-Igel*), oysters, mussels, cockles, &c. The *cuttle-fish* (*Sepia officinalis*) yields the *Ossa Sepiæ* of the apothecaries. The cover or operculum * of the *Turbo rugosus*, formerly employed in medicine, is here also sold, and the animal vended separately, at about the price of one creutzer for eight of them. The large *Jacob's Mussels* (*Ostræa Jacobæa*), cost three creutzers, and we had the advantage, besides possessing ourselves of the shells, of eating the animals, which are larger

* This is the *Umbilicus marinus* of the *Materia Medica*, where it yet holds a place, although not sold at the present day in our shops. It was formerly supposed to possess great virtues, as an absorbent and astringent; and was believed to cure the cramp, by being tied to the affected limb.—Ed.

than common oysters, and equally good in flavour. The fishwomen soon shewed us how to prepare these fish, as they supposed that we bought them, not on account of the shells, but for the sake of their inhabitants: they held them over a fire, whereupon the animal protrudes itself, and is pulled out and eaten. As they come fresh from the sea, they are sufficiently salted, and have a good deal of the true oyster flavour. On inquiring for collections of shells, we found that some women had, at their houses, whole basket-fulls laid by; but these were mostly all of one species, and partly damaged by exposure to the weather on the beach, and broken. Besides, the owners would not allow us to pick from among them, and we did not know what to do with the whole quantity; so we preferred buying the shells alive, and the more so, because we thus got a meal gratis. In this manner we purchased a quantity for our own collection, and those of our friends; containing, amongst others, *Ostræa Jacobæa*, *Turbo rugosus*, *Solen Vagina*, *Cardium rusticum*, *Venus Castrensis*, *Galina* and *ventricosa*, *Arca Glycimeris*, *Trochus magnus*, *Murex cornutus* (of which, and of *Cardium rusticum*, we purchased a handkerchief full for our own eating), *Venus reticulata*, and *Ostræa squamata* and *edulis*. From the market, M. Hohl was obliging enough to offer to conduct us to a part of the sea-shore which abounded in shells; so, having put our cockles into a place of security, we accompanied him to the spot, in the quarter of St André, where we found, indeed, a vast variety. The stones which rose above low-water mark, were all covered with the young of *Mytilus edulis*, firmly adhering to each other, and here called Lazarus' Lice (*Lazareth lause*). We picked up pieces of Madrepores, besides *Murex cornutus* and *Aluce*, *Echinus ciliaris*, and many that are sold in the market, such as *Buccinum reticulatum*, *Bulimus radiatus* of Draparnauld, *Cardium rusticum* (but in an injured state); *Arca Noæ*, *Donax trunculus*, and various *Tellinas* and *Ostræas* which are unknown to us. Here it may not be improper to observe, that those shells, which have been long exposed to the vicissitudes of the weather on the beach, are spoiled; and that those which are enveloped in a scurfy covering, must be rubbed with aquafortis, before they are made to look well in a cabinet. At the ebb-tide, numbers of women and children

come down to the strand here, to pick up what the flood-tide has left.

"On our return, we thought nothing of purchasing some potatoes in the public market, that we might have another sumptuous feast, like that of the Fichtelberg; and this we were the more induced to do, as the very best accompaniments to that vegetable, the finest red herrings, were selling for one and a-half creutzers each, and sand-eels at half a creutzer. In the afternoon we employed ourselves in the preservation of our plants. The *Ceramia* adhere by their own viscid texture to white paper, on which we expanded them, with the assistance of a pin, or some other sharp instrument. As we wanted more than 100 for our own collections, and for Funck's publication of Cryptogamic plants, we had work before us for some days. By practice, however, we got into a quicker method, and saved much time. For this employment we made use of the warm public dining-room, heated by a stove, where we had the honour to be praised by the inmates in general, and the ladies in particular, for the patience and dexterity which we evinced."

Messrs Hoppe and Hornschuch finding that the larger seaweeds, such as *Fucus vesiculosus*, *F. nodosus*, *F. serratus*, &c., turn black by the ordinary method of drying them, resolved upon trying the experiment of immersing the fresh specimens in boiling water, in the same way as is recommended for preserving succulent plants, and this plan they found to succeed perfectly to their satisfaction, the colour remaining as vivid as when they were fresh taken from the water; a hint by which our hydrophytologists will do well to profit.

On the 5th of March the travellers paid a visit to a cavern, about four hours' walk from Hundsberg, called Eggenhœfner's Cave, situated in a limestone country, and remarkable for nothing but its extent, and the miraculous escape of the person after whom it is named, who had unfortunately fallen into it. *Cornus Mas* and *Tussilago Farfara* were in full flower. In their way to Neckle, in Carniola, they passed the wood of Lippiza, the station for the *Pæonia corallina*, and where Wulfen, Scopoli, Host and Schwaegrichen, have discovered many other rare plants. The surrounding country is dreary beyond measure, yet singular, and full of caves and caldron-like excava-

tions. Into one cave, that of St Cantzien, situated in the romantic mountain on which Neckle stands, the river Reckka, the Timæus of Ovid and Virgil, flows, loses itself, and appears again near Duino. Near it our botanists gathered *Leskea complanata*, *Neckera viticulosa*; abundance of *Trichostomum fontinaloides* in fruit, and *Galanthus nivalis* in full flower.

On their return to Hundsberg, their acquaintance M. Hohl persuaded the travellers to join him in a hasty visit to Venice: whither we will at once accompany them,—not for the sake of following them through streets, squares, and public edifices, which have been so often described by travellers; but in order to introduce their account of the mode of making the glass beads which are known all over the world; and which are here, and here alone, fabricated in vast abundance. The first operations, indeed, are carried on at Murano, a place adjoining Venice.

"The furnace and the glass (white glass) are similar to what we see in common glass-houses; but mixed with the glass is a colouring substance, which constitutes the whole secret of the manufactory. This is reduced to a state of fusion, when a certain quantity is taken up with the blowpipe by a workman, and made hollow by the breath; then another person lays hold of the opposite end of the same mass, with a similar instrument, and both run with the greatest expedition to two opposite points, thereby drawing out the glass into rods, varying in thickness, according to the distance, which is often fifty feet, or more *. For the performance of this operation, there is a long walk (like a rope-walk) close by the glass-furnace.

"As soon as the rods are cooled, they are broken into pieces of the same length, packed and sorted in chests, and sent to the bead manufactory in Venice. If the rods are to be for striped beads, a small lump of coloured glass is taken from another vessel, laid in stripes on the original lump, and then drawn out in lengths. We got from this manufactory rods three feet in length, and of a finger's thickness, which had a ball blown at one end, and which are used to tie up plants in flower-pots.

* Sir James E. Smith, in his *Continental Tour*, says 150 *yards*, drawing out the rod of glass to a line only in thickness.—Ed.

" At the manufactory in Venice, a person selects from the chests, rods of the same lengths; which are cut into pieces of what size he pleases, in the following manner. The instrument employed consists of a wooden block, in which is fixed a sharp iron, shaped like a broad chisel; on this the workman lays the glass rods, and with a similar chisel-like tool in his hand, he cuts, or rather chops, them into the sizes that he wants for the beads. Hence they are taken, and put into a mixture of sand and ashes, and stirred till the hollows of the glasses are filled, which prevents them from running together in the fire. They are then placed in a vessel, with a long handle; more sand and ashes are added, and the whole set over a coal fire; stirred continually with an instrument resembling a hatchet, with a round end, by which process they obtain their globular figure. The sand and ashes are removed by sifting, and the beads themselves, after being separated with sieves, according to their sizes, are strung upon threads, packed in bundles, and are ready for exportation. The quantity thus made is astonishing. Many hundred weight stand in casks, ready filled, to be sent to almost all parts of the world, but principally to Spain, and the coast of Africa. The Emperor, during his short stay in Venice, inspected this manufactory, and gave the medal of civil merit to the proprietor, who has fixed it in his house, in remembrance of this imperial visit. Every thing was shewn us with the greatest civility; we were, besides, entertained with coffee, and presented with several patterns of glass-rods, and pattern cards, that contained not less than sixty different kinds of beads."

The famous *Theriaca* is still made, in large quantities, at Venice.

" On our return, we saw, in the neighbourhood of the Ponte Rialto, a singular scene, which greatly attracted our notice: this was the preparation of Theriaca, or Venice treacle, in the public street. On each side of a very narrow street, were placed sixteen large mortars, each provided with a pestle, moved by persons who wore a gay uniform, not much unlike that of Harlequin. The pounding was performed according to time, and accompanied by a peculiar song. The sifting was also done in the street, in the same manner. The apothecaries are mostly

manufacturers of the Theriaca, and have this inscription over their doors, in large letters, *Theriaca Mithridata* *."

At Venice, MM. Hoppe and Hornschuch took leave of M. Hohl, and proceeded in a gondola to Padua. "March 15th, we went to the Botanic Garden †, which still exhibited rather a wintry appearance. Amongst a collection of officinal plants, scientifically arranged, there were some spring-flowers, as *Hellebori, Tussilagines, Primulæ, Pulmonaria officinalis*, and *Daphne Mezereum*, in great beauty. Here were noble trees of *Pinus Pinea, Phillyrea media*, and *Melia Azedarach*, in the open air. The stoves are not remarkable.

Most of the alpine plants were in pots, under cover. We enquired for, but could not see, Professor Bonati. "Il est dejà sorti," said the gardener. At 10 o'clock we attended an anatomical lecture, and at 11 a botanical one. The Professor wore a peculiar dress; a long clerical robe, ornamented with bands spotted with black and white, like ermine, with white sleeves. He had a good delivery, and lectured upon the parts of the flower to an audience of about fifty persons. When the lecture was half finished, and the Professor intimated that he should begin the examination, there was a general clapping of hands. Each person, who was called by name to answer, stood up, pulled off his hat, and replied to the questions almost entirely from his papers, which had, perhaps, formed the subject of a preceding lecture, as nothing was taken down in writing to-day.

* Or, as it is frequently called, *Theriaca Andromachi*, because Andromachus, physician to the Emperor Nero, if he did not invent this medicine, at least sung its praises in elegiac verses. It is said to be a compound of no less than sixty four articles, animals, plants and minerals, among which viper's flesh is the principal; prepared, pulverized, and reduced by means of honey, to an electuary. At least as many diseases as there are ingredients in the composition, are said to be cured by it; and it yet holds a place in the *Materia Medica*, although nowhere to be had in such perfection as at Venice. "All the exploded articles," (says Sir James E. Smith, in his account of Venice), "of which that celebrated hodge-podge is compounded, as well as many other obsolete drugs, are only to be obtained here; especially as medicine is nearly in as dark a state in this city as it was 200 years ago." — Ed.

† This was the first institution deserving the name of a Botanic Garden, that ever was established, and was founded in 1533, by Alfonso Estensis, Duke of Ferrara, better known as the Patron of Tasso.—Ed.

At the close of the hour applause was again given, the purport of which we did not learn!

"After dinner, we visited the Cabinet of Natural History *, where we expected much gratification, having been so pleased with that of Fesel at Saltzburg. But in this we were disappointed. The collection of shells was inconsiderable. The birds and insects were still worse; the fish the best, in point of preservation. The minerals stand in need of the occasional inspection of a mineralogist; the other departments require respectively a zoologist, an ornithologist, a conchologist, an ichthyologist, and an entomologist; in order that the several collections may be completely and systematically arranged, and enriched with the newest subjects and discoveries. If, however, a single person is placed here, who, 'in omnibus aliquid, in toto nihil est,' the whole will go to ruin, and the subjects will be shortly devoured piecemeal by the maggots. We afterwards took a walk on the ramparts and the Brenta. The day was very warm, and we saw *Draba verna* in flower; but nothing of *D. muralis*, which Scopoli mentions as plentiful here.

"*Treviso, March 16th.—An Italian Walk.*—We arose in Padua early this morning, in order to proceed on our journey by the road. We breakfasted at a coffee-house in the street at Stra, and found, in our host, a German from Carlsruhe, whose name is Hoyer. We took advantage of this opportunity to procure information respecting our route. M. Hoyer thought that it would be difficult for us to reach Treviso to-day; but, if we should succeed, to-morrow we might get to Pordenone, and on the next day walk to Udine, which will be good travelling.

"From Stra we passed Dolo, Lamira, Mestre, and, in the evening, after a walk of eleven hours, arrived at Treviso. We had now passed through upper Italy: a noble country. The riches and splendour of the pristine condition of Venice were every where exhibited in the superb country houses which, like the palaces of our citizens, are seen on every side. The whole country is a continued paradise; a succession of gardens, in which the vines are led, like garlands, from one tree to another,

* Formed almost entirely, if I mistake not, by Vallisneri. ED.

between which were almonds, peaches, and other choice fruits. If these fine trees charm the eye, when clothed with the vivid colours of their young flowers; how much more must they rejoice the hearts of the inhabitants in the autumn, when their store-houses are filled with these fruits, and when their produce must almost cause them to shout aloud with thankfulness at their happy existence.

"*Fontana Fredda, March 17th.—Man proposes, God disposes.*—We had good lodgings at the Star in Treviso, though not at very reasonable charges. A German waiter was enabled to give us some useful information on various points. When we came out of the town, we saw a large board, with the inscription 'Strada per Belluno, Cadare, Conegliano, Udine,' and we were pleased at observing the names of places that were made familiar to us by the late occurrences of the French army during the war. The first, however, lay far away on our left hand, and we only passed by the last, near the gate of which, we found a noble new-made road, on which four waggons might travel abreast very conveniently. There were, besides, two rows of trees, and paling, which separated the carriage road from the footpaths on each side, and sufficiently broad to allow of two persons walking together. The whole was as level as the floor of a room; and there was not a stone to be seen. This continued for the length of some hours, while on each side we had vineyards, and, on the banks, abundance of *Primula acaulis** in flower. We crossed the Piave, and breakfasted at Conegliano, and then got to St Cäntzien about noon, keeping along a road as straight as a line, and bordered on either hand by landscapes of vineyards, but where nothing but wine was to be had. According to our instructions from M. Hoyer of Stra, we should lodge to-night at Pordenone; but this would have been a difficult task. The distance is great; the weather bad; the country unsafe;—impediments these, any one of which is sufficient to annul our plan. Nevertheless, we held on our course steadily and boldly. The road had been

* A rare plant, it may be observed, in many parts of Germany, although so common in England.—Ed.

described to us, even at Trieste, as insecure, to that degree, that we were advised not to undertake to travel it on foot. The people, they said, although robbers, are not so by habit and through indolence, like the natives of Istria; but as a matter of necessity, on account of a succession of bad harvests. The country, the towns, the natives, and their language, we were alike strangers to. We kept, indeed, in the high road, but it was destitute of passengers, or inhabited only by a few beggars; and it bordered close upon the mountains. The day was warm, and the hills covered with black clouds, which threatened a tempest even in the morning, but which broke out in the afternoon. This, however, was of short continuance; and we were soon able to proceed, after two powerful peals of thunder, and half an hour's rain. As the evening drew on, and when we might be about a couple of hours distant from Pordenone, our courage began to fail us, and we fancied ourselves in an unpleasant situation. We had never heard any particulars of this place, the houses of entertainment were unknown to us; and how could we discover a suitable one, without understanding the language, and where there are so few to be met with? We strove, however, to keep up one another's spirits; and when one expressed a wish for the appearance of the moon, the other presently fancied that he descried the shadow cast by it; but we were mistaken. We might have proceeded thus about an hour, when we perceived a light at a distance, and soon saw two men approaching us, a circumstance which created in our minds more anxiety than confidence. We at length mustered courage to accost them with "Padroni, quante miglie à Pordenone?" the reply was in good German, "Drey meilen" (three miles). We were rejoiced exceedingly at meeting with countrymen, and we gave them to understand so, by saying, "Aha! you are Germans!" Accordingly, we farther enquired of them, whether they "could not direct us to a good inn at Pordenone, where the people should not care whether good Italian was spoken?"—"Do you intend to remain there?"—"No; we shall only sleep at Pordenone."—"Who are you, then? are you Jews?"—"We are botanists, come from Venice, and going to Trieste."—"What have you got there?"—"It is a tin-box, for carrying the plants which we may gather on the road."—"Well, you have nothing

to do in Pordenone;—go into that house, if you be honest people. I live there, and you will be better off than at Pordenone; for you shall have something to eat, and it will cost you nothing." We were not long in deciding upon the acceptance of this proposal, and merely enquired, "Will you return thither; and shall we have the pleasure of seeing you again?"—"I do not know; I am like the reed shaken hither and thither by the wind, as says the Apostle John, if you know any thing of the Gospel." He now spoke to his companion in Italian, who made a low bow, and replying "Si signore, si signore," accompanied us. When we got into the house, we found ourselves in an apartment which was both kitchen and eating-room. The cloth was already laid. Our Italian spoke to the host, and we were desired to sit down. A large bottle of red wine was brought in; then came soup; then meat, preserves, fish, pastry, one after the other; so that our plates were changed six times. A dessert of fruit, cheese, and lastly coffee, concluded the repast. We had a good appetite, and relished it well They would have replenished our bottle, but we refused

"At last we intimated our desire of retiring to rest, and were shown to a room in the court, in which were two beds. When we would have fastened the door, we found that it had neither lock nor bolt; and we therefore secured it, by placing some chairs against it.

"*Udine, March* 18.—We arose very early this morning, and having removed the chairs from the door, we went into the kitchen, with the view of obtaining some information respecting our adventure. We learned that we had slept at Fontana Fredda; that our bill was already discharged; and that we had been entertained by Prince Porcia. After various reflections upon this little incident, we came to the conclusion that Prince Porcia must be a very worthy man; and that persons of high birth, and great fortune, are happy in the opportunities which, beyond others, they possess, of purchasing, at an easy rate to themselves, the gratitude and good wishes of their fellow mortals.

"We reached Pordenone to breakfast, and, as yesterday, proceeded along very straight roads, which every now and then

presented an inscription "via Eugenia;" and through a most delightful country. We crossed the Tagliamento, which afforded us occasion for three remarks, first, on the length of the bridge, which was 1800 paces; secondly, that there was not a drop of water in the river; and, thirdly, that we did not meet a single individual, while traversing the whole extent of this bridge.

"We dined at Codroipo, and meeting there with a return-carriage, we rode to Udine, a distance of five hours, for which we paid one florin. We were recommended to the White Lion to sleep. The cloth was already on the table, as is the custom of the country, and we ordered supper immediately; but when we desired to go to bed, the people of the house refused us lodgings. It would seem strange, to innkeepers of other countries, to learn, that we were desired to quit the house in which we had supped, and to seek, late at night, for another to sleep in. We therefore declared, as intelligibly as in bad Italian we were able, that we would not depart; while our host, on the contrary, protested, that we should not remain, affirming, "Ni possibile, ni possibile." At last, we offered him money to discharge our reckoning, when, on giving us back the change, he said, that we might stay, if we would give him three lire more. We paid it accordingly, and remained.

"*Gradiska, March* 19.—As our passports must be examined at Udine, which could not be done before 9 o'clock, we looked a little about the town. But as the beggars collected around us in every street, we were obliged to take shelter in a coffee-house. One importunate fellow followed us in, and when the waiter drove him out at one door, he came in at the other. We were therefore glad when we got our passports, and turned our backs on this place. Straight as the roads had been, along which we had hitherto journeyed, that of to-day was as crooked. The spring flowers, however, continued all the way, especially violets and primroses, also *Hepatica nobilis*, and *Anemone nemorosa*. We likewise observed leaves of *Asparagus acutifolius*, *Arum italicum*, and *Ruscus aculeatus*, which grew every where in the hedges, whilst, in other places, *Ulex europæus* displayed its bright golden blossoms. As we had heard, on all hands, a favourable account of the inn by the road-side, just in reaching

Gradiska, we entered it, and were well attended to by our lively hostess, and her still more agreeable daughters, which was very pleasant, after a walk of seven hours.

"*Hundsberg, by Trieste, March* 20.—The road passes on the right from Gradiska, by Montfalcone and Duino to Trieste, and is about eight hours; but as we wished to take Gortz in the way, we turned to the left, and made a circuit of three hours. The country at first was level, and the ground stony. We observed *Crocus vernus*, and *Brassica Napus* in flower. Just before reaching Gortz, where the Isonso flows, the country becomes somewhat mountainous, and the hills are clothed with brushwood, where there might be employment for the botanist.

"At Gortz the German is much spoken, but the country people use the language of Carinthia. From Gortz to Duino (five long hours), is nothing but barren soil, every where stony, and with large lumps of rock lying scattered in all directions; not the least trace of vegetation. It was not till we reached Duino, that we could meet with any botanical fare. Here the sea had considerably encroached upon the land, which, for a great extent, was intersected with brooks, forming a wet soil, and covered with rushes. This is the place celebrated in Schrader's *Flora Germanica* for rare *Cyperaceæ*; such as *Cyperus australis, esculentus, longus, Monti, Scirpus littoralis*, &c. Now, however, nothing was to be seen of these plants; yet it gave us pleasure to be able to visit the place where they grew. Our zeal was better rewarded in an adjoining wood. *Ulmus campestris* was in flower; and what was remarkable, we found only female inflorescence. Here was also *Quercus Ilex*, not yet in flower, forming not large, but bushy trees; its outline resembling a clipped *Yew*, or a *Lombardy Poplar* with its head cut off. We now soon came in view of the Adriatic. Still the barren soil (Karsch) continued to Duino, and even to Santa Croce. Near Prosecko we came into a "pays de connaissance" We saluted Contobello, admiring the fine view which it afforded us of the ocean; and, after a walk of twelve hours, arrived late in the evening at our old quarters at Hundsberg.

"*Hundsberg, March* 21*st*.—Thus terminated our little land and water excursion. We have seen Venice,—a city unique in its kind, and many other interesting places; and have traversed

a rich and fertile tract of country. From Padua we had a walk of fifty hours, which we accomplished in five days, favoured, as we were, with a continually clear sky, and warm weather. Even the thunder storm at Cantzien did not delay our progress, for we employed the interval in eating our dinners. We are therefore justified in saying, that the remembrance of this little tour will afford us pleasure as long as we live, notwithstanding that Venice is the worst place in the world for a botanist. We have examined to-day the contents of our presses, and found, amongst other things, that *Helleborus viridis*, which had never been removed from the papers in which it was first placed, was extremely well preserved, and retained its colour perfectly. This we attributed to the plenty of *warmed* paper which we made use of."

(To be continued).

Art. XIII.—*Description of a New Reflecting Microscope.* By David Brewster, LL.D. F. R. S. Lond. & Sec. R. S. Edinburgh, &c. &c.

The various forms which have been given to the Reflecting Microscope are necessarily derivable from those which have been given to the Reflecting Telescope; and the one instrument is nothing more than the other either inverted, or modified for the examination of near objects.

The reflecting microscope of Dr Barker * is the Gregorian telescope lengthened, so as to permit it to act as a microscope. The reflecting microscope of Dr Smith is the Cassegrainian telescope, with this difference only, that the convex mirror is perforated to allow the rays of the object to pass through it, whereas, in the telescope, the rays pass without the convex mirror †. The microscope of Professor Amici of Modena is also an inversion of the Newtonian telescope; and the reflecting microscope which I have proposed in the article Microscope, of the Edin-

* See Phil. Trans. 1736, vol. xxxix. p. 259.

† A microscope will perform very well, when it is made exactly like the Cassegrainian telescope.

burgh Encyclopædia (vol. xiv. p. 224.), is the Cassegrainian telescope in an inverted form. In like manner, the microscope which I intend now to describe, is an inverted form of the reflecting telescope, described in vol. vii. p 323. of this Journal.

This microscope is represented in Plate VII. fig. 16., where ABCD is a tube supported horizontally, upon a stand ST, with a draw tube E containing an eye glass. An ellipsoidal speculum AB, having its two foci at F, *f*, is placed at the other end of the tube, and an *achromatic prism* GH, constructed in the manner described in this Journal, vol. vii. p. 326., is placed between the mirror AB and its nearest focus F. An arm KL, projecting from the stand ST, carries at its end K an inclined ring, for holding the object sliders, and the object, such as *m n*, may be illuminated either in front, if it is opaque, or by a mirror below, if it is transparent.

When the distance of the object *m n* from the prism GH is equal to the distance of the prism from F, the refraction, by the prism, of the rays proceeding from the object *a b*, will make them fall upon the speculum AB, as if they had proceeded from F, and a magnified image of it will be formed in the other focus *f*, which will be again magnified by the lens or lenses placed at E.

The advantages of this microscope may be estimated in exactly the same manner as has been already done, when we described the analogous combination in the form of a telescope. The prevention of the loss of light by reflection from the second speculum is the chief advantage of this construction, and has been already fully explained.

When reflecting microscopes are constructed on a very large scale, as recommended in a former article (see this *Journal*, vol. vi. p. 105.), the small speculum, or the glass prism, may be entirely dispensed with, and the whole effect may be produced by oblique vision, as in the large telescopes of Sir William Herschel.

Edinburgh, *Mar.* 4. 1823.

Art. XIV.—*Remarks on the Increase of the Population of the United States and Territories of North America, with Original Tables, deduced from the American Population Returns, to illustrate the various Rates of Increase in the White Population and Slaves, and also the comparative degrees in which Agriculture, Commerce, and Manufactures prevail.* By George Harvey, Esq. M.G.S., M.A.S., &c. (Continued from p. 55.)

The Table which concluded the first portion of my Essay, in the last Number of this Journal, presents results of a more striking and remarkable nature, than any which have been drawn from the tables formed to illustrate the other divisions of the survey of the American population *. Since 1810, Indiana has added its immense increments to the Middle States, surpassing even the rapid rates of increase which distinguished Ohio in the former decade. In the Southern States, also, we find the returns for Louisiana presenting results scarcely less remarkable. And in the Territorial Governments, we have the fertile districts of Alabama, Illinois, and Michigan, each contributing their mighty increments, to swell and augment the tide of population.

Among the Northern States, it is curious to trace the growth of the district of Maine, when contrasted with that of Vermont. In the enumeration for 1790 to 1800, the increments of the former were decidedly inferior to those of the latter; and in the period from 1800 to 1810, the comparative rates of increase were somewhat of an uncertain kind, the ascendancy being found for some of the ages in one state, and sometimes in the

* The reader is requested to correct the following typographical errors in the Tables belonging to the former part of this essay:—To place the sign *minus* before the number belonging to the free white males under 16 in Rhode Island, page 50.; also in the state of Connecticut, and in the class of males under 10, in p. 52. to substitute — 0.4 for 50.1; and in the same page, to place the sign *minus* before the number belonging to the free white females of 45 and upwards. Also in the Table, p. 55., to introduce the same sign in the following places, viz. before the numbers for the males and females in the class under 10, in the states of Connecticut and Vermont; before the numbers belonging to the first, second, and fourth classes of males, and the first and second classes of females, in the state of Delaware; and, lastly, in the second class of males belonging to Illinois, to alter 37.3 into 347.3.

other; but in the census for 1820, the district of Maine will be found to have gained a positive superiority in every age;—all the increments, and particularly those of the female class, being considerably raised above those of Vermont. In the latter state, indeed, we find the change to have been so remarkable, as to create decrements in its youngest class of males and females. Connecticut, likewise, is distinguished by decrements in its youngest classes; but the transitions are much less remarkable: for, in the former decade, the youngest class of males belonging to this state, was distinguished by a feeble diminution of its numbers; and the females of the corresponding class approached very nearly to a stationary state. But in Vermont, the change has been from increments of considerable and nearly equal magnitude, to decrements of a less equal kind. The second class of males and females has also undergone variations of a remarkable kind. The greatest increments which the population of this state received from 1810 to 1820, are in the three last classes of each of its sexes.

If we contrast the present Table for New Hampshire, with the results of the former decade, the increments will be found to possess some curious relations. The first, second, and fourth classes of its males, and also the first, second, third and fourth classes of its females, for the last ten years, have increments inferior to the corresponding rates of increase of the former decade; but the increments of the classes of the two sexes for the latter period, exceed the corresponding ones of the former. In Massachusets, with the exception of the last class, the increments alternate with the corresponding increments of the former period, from less to greater, and from greater to less. The first and second classes of males in Rhode Island, exhibit also a relation of this kind; and so also do the three last classes of females. The alternating changes which exist in the increments of Massachusets, are not, however, to be traced in the fine province of New York, all the augmentations which its different ages have received, being inferior, in point of magnitude, to the corresponding increments of the preceding period. There is, however, a greater degree of uniformity, and a closer connection, among the increments of this province, than in many others. In New Jersey, the increments for the first class of each sex

are very intimately allied to each other in the two periods; the rates of increase for the males being respectively 11.5 and 11.2, and the females 10.5 and 10.7. There is also a curious relation between the third and fourth classes of males for the two periods; the increment of the third class in the former decade being nearly double the increment of the same class in the latter decade; and the increment of the fourth class, during the last ten years, being also double the corresponding class of the former period. The small increments of the males and females of 10 and under 16, when compared with the other increments, afford a contrast somewhat remarkable. Pennsylvania is likewise distinguished for the close approximation of the increments of the first classes of its males and females, and so also are Maine, Massachusets, Connecticut, New Jersey, Ohio, Georgia, Louisiana, Tenessee, Kentucky, and Alabama. These coincidences are, however, better exhibited in a Table.

States and Territories.	Increments of the Males under 10.	Increments of the Females under 10.	Differences.
Maine, - - -	+ 19.2	+ 18.9	+ 0.3
Massachusets, - -	+ 2.9	+ 3.6	—0.9
Connecticut, - -	— 2.6	— 1.8	+ 0.8
New Jersey, - -	+ 11.2	+ 10.7	+ 0.5
Pennsylvania, - -	+ 26.6	+ 26.5	+ 0.1
Ohio, - - - -	+ 139.5	+ 139.9	— 0.4
Georgia, - - -	+ 26.6	+ 26.2	+ 0.4
Louisiana, - -	+ 213.7	+ 211.3	+ 0.4
Tennessee, - -	+ 52.3	+ 51.7	+ 0.6
Kentucky, - - -	+ 27.5	+ 27.7	—0.2
Alabama, - - -	+ 192.5	+ 193.6	—1.1

The column of differences exhibits the close approximation of the male and female increments to each other; the positive signs showing that the excess is on the side of the males, and the negative signs that it is on that of the females. In no case is the difference greater than 1.1; and in by far the greater number of cases it is less than 0.5. The positive differences amount to + 3.1, and the negative to — 2.6, the difference between the two aggregates being only + 0.5;—a coincidence as singular and remarkable as any before observed. And when we consider the diversity which reigns among the increments themselves, and connect with them the uncertain nature of the causes which have contributed to the growth of the population in the respective

provinces, we cannot but consider it as singular that so close an approximation to equality should exist.

In the state of Delaware, the first, second, and fourth classes of males, and also the first and second classes of females, are distinguished by changes of a decreasing kind. Two other classes of the females, namely, the third and fourth, received only increments of a very feeble kind. The results also of the enumeration for the period comprised between 1800 and 1810, exhibited some singular relations, containing the only example of a class of persons, altogether stationary, and also of two other classes approximating very closely to the same state. In the decade from 1810 to 1820, there are likewise three classes of a similar kind. The magnitudes, also, of the increments of the last class of each sex, must be considered as very great, when contrasted with those which precede them. Causes of a very peculiar nature must have operated on the state of Delaware, to have produced such a series of increments as have here been referred to.

The equality which exists in the first class of the male and female increments of Ohio, has been already noticed; but it is also deserving of remark, that the fourth class of males possesses an increment precisely similar to the first. In the period from 1800 to 1810, the maximum male and female increments were found in the final classes; but in the succeeding census, it was only found to hold good in the females, the greatest increment in the male population being found in the third class. This circumstance is most probably to be accounted for, from the immense number of young men who have been known to emigrate to the state of Ohio, in consequence, probably, of an impression which was at one time very strong in the public mind, that it possessed advantages superior to any other American state, and hence was resorted to by multitudes of the young mechanics of England.

In Indiana, notwithstanding the increments are so very great, a considerable degree of uniformity prevails among them, the average of the male rates being 513, and of the females 514.4, —a remarkable approach to equality, when the irregular nature of the operating causes is considered. This tendency of nature to produce a balance in her aggregate operations, is also cu-

riously displayed in the state of Louisiana, where the male increments of the first and second classes, although but little more than half the magnitude of the third, and, we may add, the fourth increment also, and therefore presenting no kind of uniformity whatever; yet their means does not differ very widely, considering the magnitude of the increments, from the mean of the almost equally irregular increments of the females; the former being 358.7, and the latter 342.9. It is remarkable, however, that the maximum female increment should be found in the final class, corresponding in this respect with Ohio, Indiana, Missisippi, Michigan, and Columbia;—Alabama being a singular exception to the law. The maximum male increments are found in the third class, in the states of Ohio, Indiana, Louisiana, Alabama, Illinois, and Michigan,—confirming the remark before made, relative to the immigration of young mechanics. A more particular account of the maximum increments will be given in a succeeding page.

Among the southern states, Louisiana, as has been already remarked, is distinguished by the magnitude of its increments, and also by the irregularity of their character. The impulse which its male population has received in the third and fourth classes, are among the most striking of the results which the present survey has disclosed. Next to the increments of the last-mentioned state, we may rank those of Tennessee, Kentucky, Georgia, and North Carolina, all of which present conclusions more or less interesting. Of the three remaining southern states, it is difficult to determine which is the greatest, from the uncertain nature of their increments. Of the two Carolinas, it may be observed, as somewhat singular, that the fourth and fifth increments of males, and the second increments of females, should so closely agree, notwithstanding the results of the other ages bear no perceptible relation to each other. Georgia and Kentucky also correspond in the first and third classes of its males. The large increments, moreover, which both the sexes of 45 and upwards received during this period in the two Carolinas, may not be unworthy of attention, particularly as they afford a striking contrast to the increments of some of the other ages. In Georgia, also, the first, third, and fourth classes of males, are respectively equal, or nearly so, to the corresponding classes of fe-

males, and likewise to the class of 45 and upwards. The first three classes, for both sexes, in the table devoted to the former census, exhibit likewise a close approximation to equality. Causes, therefore, somewhat of an uniform kind, have probably operated in Georgia during these periods, on particular classes of the two sexes.

Perhaps the most singular class of increments in the whole series, is that belonging to Alabama. Among the males, the most striking examples of disparity will be perceived to exist in the first three classes, and the two latter. The third class has an increment of 215.1 per cent., and the last only 62; the latter an increment large, when regarded as indicating the rate of increase during so short a period as ten years, but small, when contrasted with so great an increment as the former. Such increments afford the means of discovering to which class of persons the province has been most indebted for its increase. It will be remarked, that the very large increments which belong to the third class, proves that a great number of young men must have emigrated to this territory, carried thither by the tide of fortune, and the adventurous spirit which the young possess. The increments of the first and second classes may have been produced as necessary consequences of the fourth and fifth; for these, consisting probably of by far the greater part of married persons, necessarily carried with them their families, and which circumstance contributed to give that impulse to the first and second increments, which they appear to have received. Perhaps some portion of the large increment of the third class may be attributed to this cause. It is very remarkable, however, that the state of Missisippi, which would seem to be almost as much subject to the uncertain influences of immigration as Alabama, should present results so very different from those last mentioned. For instance, the minimum increments for each sex are found in the class of 45 and upwards, in the territory of Alabama; whereas in that of Missisippi, the maximum increments of each sex are to be found in that class. The anomalies, also, which will be found to arise from comparing any corresponding ages together, in the states last mentioned, are very remarkable. If we select, by way of example, the first and last classes, for each sex, as in the following Table,

Territories.	Increments in Ten Years.			
	Males.		Females.	
	Under 10.	45 and upwards.	Under 10.	45 and upwards.
Alabama,	192.5	62.0	193.6	93.1
Missisippi,	92.2	100.7	79.8	136.8

the results will be found of a very dissimilar kind. The large increment of Alabama, is succeeded by one of a comparatively small magnitude in both sexes; whereas in Missisippi, the contrary takes place, the lesser rate of increase being followed by the greater; and it would seem as if the greatest and least rates of increase had mutually interchanged places with each other. How uncertain must have been the causes which contributed to produce conclusions so much opposed to each other as these! In Illinois, considering the great magnitude of all the increments, a greater degree of uniformity will be observed to prevail among them, than in either of the territories last reviewed. The transitions from one rate of increase to another, are not of so abrupt a kind as in those prevailing in the state of Alabama. In Michigan, the greatest male increment will be found in the third class, produced probably by the causes operating on Alabama. If we contrast the increments of the sexes of this state, as in the next Table,

Sexes.	Increments in Ten Years.				
	Under 10.	10, and under 16.	16, and under 26.	26, and under 45.	45, and upwards.
Males,	52.5	65.0	128.8	117.7	79.1
Females,	76.5	58.1	88.0	91.3	104.6

their great irregularities will be immediately apparent. If the results of the first column, for example, be compared with each other, no one could anticipate such conclusions as the third and fourth columns present, at least not from the ordinary laws of human procreation *.

* For the use of those who may feel desirous of contrasting the rates of increase in Sweden, with those of the different American states (a subject on which

In the observations which were before advanced, relative to the maximum increments from 1800 to 1810, a great degree of regularity was observed to prevail among them; and it was remarked, that both males and females could be separated into two classes, and that the greatest increments of each state fell in one or other of them. These classes were the third and fifth. The same principle has been attempted to be traced in the greatest increments contained in the table for 1810 and 1820, but not with the same success, two exceptions being found to it in the males, and five among the females. Nevertheless, the law before observed will be found to hold good, with respect to the males, in twelve states, in the class of 16 and under 26; and in eleven states in the class of 45 and upwards. Of the females, four states only will be found in the former of these classes, but in the latter sixteen;—another evidence in favour of the suppo-

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it is my intention to offer a few remarks in another paper), the following Tables are added. To enable the comparison to be made with greater ease, the Swedish returns have been thrown into five classes, corresponding, as nearly as circumstances will allow, with the American divisions. It is a matter of regret to be obliged to depart, in an inquiry of this kind, from a classification of ages, so truly philosophical as that which has been matured by WARGENTIN, and the other enlightened members of the *Tabellverket*, or Board of Population, to assimilate it to one less perfect and useful. Time, however, may do that for the American returns which it has done for the Swedish. Rome was not built in a day.

Rates of Increase of the Swedish Population.

Periods.	Males. Under 10.	Males. 10 to 15.	Males. 15 to 25.	Males. 25 to 45.	Males. 45 and upwards.	Females. Under 10.	Females. 10 to 15.	Females. 15 to 25.	Females. 25 to 45.	Females. 45 and upwards.
1757 to 1760,	+ 4.1	+ 6.0	— 0.2	+ 0.1	+ 0.0	+ 4.1	+ 4.7	+ 0.1	+ 2.7	— 0.5
1760 to 1763,	+ 0.3	+ 4.3	+ 7.6	+ 0.6	+ 2.9	+ 0.3	+ 7.1	+ 1.8	+ 3.7	+ 0.9
1763 to 1800,	+ 27.2	+ 21.9	+ 33.9	+ 31.7	+ 40.4	+ 26.3	+ 19.8	+ 32.1	+ 29.4	+ 32.0
1800 to 1805,	+ 3.4	+ 9.5	+ 3.4	+ 3.7	+ 1.6	+ 4.1	+ 9.9	+ 2.7	+ 3.2	+ 5.0

sition, that it is the result of some law. The following Table, however, will more completely show the states and territories which conform to this law, and those which deviate from it. The females present the greatest irregularities.

States and Territories in which the Maximum Increments of Males are found.		
16, and under 26.	26, and under 45.	45, and upwards.
Connecticut. New York. New Jersey. Pennsylvania. Ohio. Indiana. Maryland. Virginia. Louisiana. Alabama. Illinois. Michigan.	Massachusets. Rhode Island.	Maine. New Hampshire. Vermont. Delaware. North Carolina. South Carolina. Georgia. Tennessee. Kentucky. Mississippi. Columbia.

States and Territories in which the Maximum Increments of Females are found.				
Under 10.	10, and under 16.	16, and under 26.	26, and under 45.	45, and upwards.
Alabama.	Illinois,	New York. New Jersey. Pennsylvania. Virginia.	Massachusets. Rhode Island. Connecticut.	Maine. New Hampshire. Vermont. Delaware. Ohio. Indiana. Maryland. North Carolina. South Carolina. Georgia. Louisiana. Tennessee. Kentucky. Mississippi. Michigan. Columbia.

The preceding survey has afforded the most ample grounds for presuming, that the increase of the American population has not proceeded from progreation alone. To indulge such a supposition, indeed, would be to attribute to the operations of nature a series of irregularities of the most improbable kind. If we select, by way of example, the greatest and least rates of

increase of the males, for the four great divisions of the states and territories, during the period last reviewed, as in the following Table,

		State or Territory.	Under 10.	10, and under 16.	16, and under 26.	26, and under 45.	45, and upwards.
Northern States,	Maximum,	Maine,	19.2	14.7	39.8	25.6	44.3
	Minimum,	Connecticut,	— 2.6	0.9	8.2	8.2	6.5
Middle States,	Maximum,	Indiana,	501.8	495.9	531.7	507.6	528.1
	Minimum,	Delaware,	— 6.2	— 0.1	7.1	— 4.6	13.4
Southern States,	Maximum,	Louisiana,	243.7	250.2	457.8	443.1	398.7
	Minimum,	Virginia,	6.3	6.6	14.1	10.1	8.3
Territories,	Maximum,	Illinois,	365.8	347.3	388.6	329.8	375.0
	Minimum,	Columbia,	32.2	32.1	42.8	37.3	49.1

we must immediately admit the propriety of considering a very large proportion of the increase as arising from immigration. And although, in the present imperfect state of our statistical knowledge, it may be impossible to fix, with any thing like precision, the several degrees in which procreation and immigration have prevailed, so as to produce results so singularly diversified as those which have been the object of the preceding pages to survey, there can be no doubt but that, in many of the states, the latter cause must have been decidedly the most powerful in producing them. On another occasion, an opportunity may be afforded for discussing these important relations; but, in the mean time it may be remarked, that it does not appear, from the evidence with which we are at present furnished, that the laws which influence procreation in the New World are materially different from those which prevail in the Old. Subsequent inquiries, and more authentic documents than we at present possess, may throw a new light on the subject, and diminish the impression which has been made on the minds of many enlightened men, that the rapidity with which the American population has increased, is more to be attributed to immigration than to any other cause. Still the inquiry must be approached with caution, and, in the absence of so many necessary data, even speculation itself may be useless. If we consider, however, the present condition of Europe, and the causes which contribute to

render the maintenance of a family difficult and distressing to the labourer, and contemplate the advantages which the western regions of America disclose, where the wages of industry are high, and where the *real* labourer enjoys the best fruits of the earth in abundance and peace, we may perceive at least some ground for presuming, that the effects of immigration have been great. In no antecedent state of the world has so immense and so indefinite a theatre been opened for the increase of the human race, not only, it is to be hoped, in number, but also in wealth, happiness, and virtue. At the present moment, we can contemplate a surface of fertile country upwards of 2000 miles in extent, reaching from the present remotest settlements to the shores of the Pacific Ocean, enjoying all the blessings of the temperate zone, intersected by innumerable streams, possessing the primitive and undecayed energies of nature, and capable of affording, for centuries to come, the best fruits of the earth in unlimited abundance.

It is in the newly settled states that we have met with the largest rates of increase; and there is no room for supposing, but that a large proportion of their inhabitants will acquire fixed and settled habits, and thus possess the means of calling into full and perfect exercise all the active principles of population. These considerations, joined to the farther influx of other settlers, must, in subsequent years, give a prodigious impulse to their numbers. Some portion of the inhabitants of these new states will, it is true, retain their migratory habits; but this, so far from proving any check to the population, will rather be the means of increasing it more rapidly. On the uncertain frontier of the American territory, " where civilized gives place to savage life," crowds of such adventurous emigrants resort, " dispensing with the advantages, and exempted from all the restraints, of social life. Here they act in the double capacity of cultivators and huntsmen, partly civilised, and partly savage, until, by the advance of new emigrants, they are gradually surrounded with improvements on every side, and are at length brought within the pale of order and law. Tired of this controul, and anxious to resume their free and licentious habits, they dispose of their lands to emigrants of a more settled character, and again take their station on the verge of the desert, there to bear the

brunt of savage hostility, to hunt and to cultivate, and, by their resolute and ferocious habits, to repress the inroads of the exasperated Indians, and to act the part of successful pioneers, in clearing the way for the great mass of the American population. It is in this manner that the country gradually assumes the aspect of civilization, and that the dwellings of men are seen to take place of the haunts of wild beasts." The migratory habits of such men, so far, therefore, from proving any check to the increase of the population, actually prepare the elements for a more effectual advancement of it. The labours and difficulties of the few, become the means of promoting the happiness and welfare of the many. And in the states and territories which have been latterly peopled, a few years must produce a race of inhabitants attached to the country in which they have taken up their abode, from the exercise of those sympathies and attachments which so soon spring up, and find root in the human breast; but above all, by the strong conviction which they will most probably entertain, that their present condition is better than that which they have left.

It may also be remarked, that the principles of population will be called into more active exercise, in the early stages of a newly settled state, than in its late growth. This will appear manifest, when we consider, that, in the first settlement of a state, the most fertile tracts of country will be first occupied, and which, by affording the means of subsistence in greater abundance than when the less productive parts become settled, must necessarily give a greater impulse to the population, in its former stages, than in its latter. It is also probable, that, by even supposing the agricultural population to predominate for a considerable period in the newly settled states, considerable diversities will arise among the increments of the inhabitants of different districts of the same territory, from the operations of the same cause. It is time, however, to hasten to the contemplation of a subject which makes a loud appeal to humanity,—the SLAVES.

(To be continued.)

ART. XV.—*Analysis of a Journal of a Voyage to the Northern Whale-fishery; including Researches and Discoveries on the Eastern Coast of West Greenland, made in the Summer of* 1822, *by* WILLIAM SCORESBY, jun. F. R. S., M. W. S., &c. &c.

THE original design of the voyage, an account of which is given in the present work, was the prosecution of the whale-fishery on the coast of Greenland and Spitzbergen. Discovery, Captain Scoresby tells us, was an object, therefore, that could only be pursued subserviently to it, but it fortunately proved compatible with the principal purpose of the voyage. The choice of the fishing ground being left to our author, he preferred the coast of Greenland to that of Spitzbergen. This was not only, in his opinion, the most promising station for success, but likewise most agreeable to his wishes, as affording a chance of making important geographical discoveries. The result was highly satisfactory. The fishing proved successful, and an extensive unknown country was discovered. Wholly unassisted, and under very disadvantageous circumstances, Captain Scoresby executed the survey of a wild and terrible coast,—explored many of its sounds, bays, and islands,—and was also enabled to enrich science with numerous new and interesting observations and views.

The experience of these three or four last years having demonstrated the ruinous nature of the whale-fishery in Baffin's Bay, it will probably be entirely abandoned, and consequently the importance of the Greenland fishery, where the losses have been comparatively small, will rise in importance. It cannot therefore be doubted, that the researches made during this voyage on the coast of Greenland, will prove of great consequence to our trade in that quarter, and that they will afford such information as may be the means of advancing the prosperity, and increasing the safety of those engaged in this adventurous employment. The re-discovery of the ancient Greenland colonies was also an interesting object in the voyage; and Captain Scoresby found, in every place where he landed, traces of human inhabitants, generally of Esquimaux; but, for reasons stated in the Journal, it appears that descendants of Europeans also formed part of its population.

In the Introduction to the Voyage, we are presented with a history of the ancient settlements on this coast, and of the many attempts made to re-discover them. Although all these attempts proved abortive, owing to the vast body of ice, extending to a great distance from the shore, it appears, from the observations contained in the Journal now before the public, that the coast is not inaccessible at present, but, on the contrary, that it may be visited annually. If the coast, from the Arctic Circle to Cape Farewell, be really defended by a barrier of ice, as is the general opinion, of the accuracy of which, however, our author has great doubts, the course he recommends to be pursued is a parallel betwixt the latitude of 69° and 75°, in some part or other of which limits, and frequently in many different places, the coast may be reached every summer; and, when the navigator once gets betwixt the land and the ice, there would be no great difficulty in reaching any of the stations of the old colonies, even down to Cape Farewell, the southern promontory of Greenland. Our author, in communicating his discoveries and observations, and in relating the various interesting incidents of the voyage, has chosen, and with great propriety, the journal form We shall, therefore, in the account we are now to lay before our readers of the contents of this important work, adopt the same order.

The ship Baffin, commanded by Captain Scoresby, in which the voyage was made, appears to have been admirably fitted for the Greenland Seas., The various arrangements for the purposes of the whale-fishery were of the most complete kind, and nothing was neglected which could contribute to the comfort, and secure the safety of the crew. All the preparations and arrangements being finished, the Baffin sailed from Liverpool on the 27th March 1822. On the 28th, they were forced, by stress of weather, into Loch Ryan. During the leisure afforded by this detention, our author employed himself in constructing a temporary apparatus for obviating the errors produced on the rate of chronometers by the action of terrestrial magnetism on those parts of the instruments which are formed of steel. The weather having become favourable, they left Loch Ryan on the 7th April; on the 10th, passed the Island of Tiree; and the following day, at day-break, discovered the wild and solitary rock of St Kilda, which was passed at noon.

"The ship being now fairly at sea, the ship's company were divided into three 'watches,' containing an equal proportion of harpooners, boat-steerers, &c. This arrangement, which the large complement of a Greenland ship's crew renders easily practicable, gives each man, excepting on extraordinary occasions, 16 hours rest out of 24. This is a great relief to them in cold weather, and serves to compensate them for the extraordinary exertions to which they are sometimes called. At the same time, we appointed a crew of six or seven men for each of our seven whale-boats, for the purpose of getting them fully prepared and fitted for the fishery, and for keeping them in order when on service." P. 13.

On the 10th, they passed to the westward of the Faroe Islands, at no great distance; and, on day-break of the 14th, *fell in with ice*, about 150 miles to the eastward of Iceland, in so low a latitude as 64° 30′ N.,—a position in which Captain Scoresby had never before seen ice.

"It must," he remarks, "have been brought hither by a continuance of strong gales from the NW. Its effect on the climate of Iceland, the whole of which island the ice appeared at this time to envelope, must have proved both disagreeable and baneful to the inhabitants. In summer, the ice generally retires far from the coast; but during the preceding 18 months, it is probable that the northern parts of the island were never free from its chilling influence. Towards the end of August 1821, a season when the ice should have retired to its greatest distance from the shore, I found the promontory of Langaness encompassed by large streams of heavy drift-ice, which it appears never left the coast the whole of the summer. The effect of this on the temperature was most striking. In descending from Lat. 71° to 67°, the highest observation of the thermometer was 38°, and when close in-shore, near Langaness, it was 35° at mid-day, and 32° early in the morning. It might be reasonably expected, that such a degree of cold in the height of summer would be destructive to vegetation, and, consequently, most dangerous to the cattle, whose supply of herbage in this quarter is at all times scanty; yet, in the interior, we are informed, by the Danish journals of the period, that the summer of 1821 was uncommonly warm." P. 14, 15.

On April 15. they forced their way through the ice, and got clear of it in the evening. The weather all day was delightful. The Latitude at noon was 64° 41′. An hour or two before midnight, a splendid aurora borealis made its appearance, and the following excellent description is given of it.

"It commenced in the north, and extended itself in an arch across the zenith, towards the south. A sort of crown was then formed in the zenith, which was most brilliantly illuminated, and gave out innumerable coruscations of great beauty, and with astonishing velocity. The light appeared to be equal to that of the full moon; and various colours, particularly blue, green and pink, were stated by my officers to have been clearly observed. Its extreme distinctness

and the boldness of the coruscations, seemed to bring it to a low elevation; and, when the rays were darted towards the ship, it appeared almost to descend to the very mast-head.

"Between the parallels of 62° or 63° and 70°, the aurora borealis is of very common occurrence, in the spring and autumn of the year. On the 3d of April 1820, I observed the most interesting display of this meteor that nearly forty passages to and from the fishery had afforded. The evening was fine and clear, the wind westerly. The aurora first appeared in the north, and gradually extended in a luminous arch across the zenith, almost to the southern horizon. A dim sheet of light then suddenly appeared, and spread over the whole of the heavens to the eastward of the magnetic meridian, while only a few insulated specks were visible to the westward. The eastern auroræ were grey and obscure, and exhibited little motion; but the arch extending across the zenith, showed an uncommon playfulness of figure and variety of form. Sometimes it exhibited a luminous edge towards the west, in some places concentrated into a fervid brilliancy. The rays were a little oblique to the position of the arch; but generally parallel to each other, and commonly ran in the direction of the magnetic north and south. At one time they extended sideways against the wind; at another in the contrary direction. Now they shot forward numerous luminous pencils, then shrunk into obscurity, or dispersed into the appearance of mere vapour. The colours were yellowish-white and greyish-white. All the stars of the fourth magnitude were visible through the meteor, even in its most vivid coruscations. *Ursa Major* was at one time encircled with such a characteristic blazonry of light, that the Bear seemed to spring into figure, and to be shaking his shaggy limbs, as if in contempt of the less distinguished constellations around him. The Pleiades were almost obsured by the light produced by the aurora; though Venus, and all the superior stars, shone with becoming splendour. I have never been sensible that the shooting of the aurora was accompanied by any noise; the turbulence, indeed, of the water at sea, or noise of the sails during calms, prevents slight sounds from being heard." P. 16-18.

For some days after the aurora borealis, the weather was fine. During a run of 50 leagues, the sea was constantly of an olive-green colour, remarkably turbid; but, on the afternoon of the 17th April, it changed to transparent blue. This green appearance of the sea in these latitudes, was occasioned by myriads of small marine animals. A calculation of the number of these animals, in a space of two miles square, and 250 fathoms deep, gave an amount of 23,888,000,000,000.

Their Latitude, on the 17th, was 65° 58′, Long. 3° 53′ W. A great quantity of drift-wood passed during the day. Two trees were picked up, one of which was about 30 feet in length. This wood is probably derived from some of the great rivers of Siberia, which empty themselves into the Frozen Ocean, and being

carried by the westerly current prevailing on this coast, is dispersed throughout the Greenland Sea. The wood is pine and birch. It is not uncommon to find trees imbedded, in an upright position, in the middle of large sheets of ice,—a circumstance which, our author remarks, is in favour of the supposition of such ice having been formed near land. On the 18th, they again fell in with ice. The day following, at noon, having had a good run during the night, Captain Scoresby observed in Lat. 68° 45′, Long. by chronometer, 0° 8′ W. The variation was found to be only 14° W., on a NE. by E. course, but the real variation must have been about 22°, the difference of 8°, being the effect of the "local attraction" of the ship on the compasses.

"The amount of 'deviation' on every point not being yet ascertained, nor the points of change, we sailed in considerable uncertainty, whenever an alteration in the course was necessary. The Baffin having an iron-tiller, and much heavy iron-work about the rudder, has an extraordinary deviation in her compasses. In her first voyage (1820), it was still more considerable, and not a little dangerous before it was discovered. It produced an error of a degree of latitude in one day's run, on a NE. by E. course,—the deviation on that point being twenty-two degrees. On carrying a pocket compass round the quarter-deck, to ascertain the cause of attraction, I discovered that it was principally owing to the piping or chimney of the cabin-stove, which had inadvertently been made of sheet-iron, and had consequently an attractive energy (according to Mr Barlow's investigations) equal to a pillar of solid metal, of the same quality and diameter." On removing this chimney, though eight feet distant from the binnacle, the deviation was diminished more than two-thirds." P. 21, 22.

On Sunday, the 21st April, had a hard gale from NE. and NNE., but which having been foreseen by means of the barometer, proper precautions were taken to secure the vessel from its effects. A little before sunset on the 22d, a *weather-gall* (or the limb of a rain-bow) of great brilliancy, appeared. The weather-gall is generally considered by seamen as the harbinger of a storm; and we find, from the Journal, that the next day was stormy. On the 25th, observation was made in Lat. 75° 5′. For two or three nights preceding this, Captain Scoresby says "we had no darkness, but only faint and diminished twilight. Now we were advanced into the regions of continued day, where the sun, for months together, sweeps round the North Pole without ever descending below the horizon."

Having now reached a *fishing latitude*, preparations were made for the fishery. The number of boats was seven. In each of them were coiled six whale-lines, of 120 fathoms. They were also fitted up with all the apparatus of harpoons, lances, oars, axes, flags, &c. as usual in their equipment. On the 27th April, at 5 P. M., the ship passed the 80° North Lat., being within ten miles of Hackluyt's Headland, in Spitzbergen, *a latitude which was reached without experiencing any frost.* In the evening, the wind coming off shore, the sky immediately became clear, and displayed a large extent of the northern coast of Spitzbergen, of which the following description is given.

"This coast is much lower land than the western, and more uniformly covered with snow, few ridges or even points of naked land, being visible. The western coast, on the other hand, presents alternate streaks of black and white. The former colour, consisting of ridges of naked rock, which appear black, contrasted with the brilliant whiteness of the snow, frequently runs from the summit directly towards the base of the mountain, but oftener becomes concealed beneath a bed of snow and ice, as it approaches the water's edge: the latter colour, the white, consisting of snow and ice, fills all the ravines, dells, fissures, and valleys, and reflects the light of the sun with such intensity, that the tracts of snow-clad land exhibit, as near as possible, the colour and splendour of the moon at the full. The ice and rocks being thus highly illuminated, and strongly contrasted,—being constructed on a majestic scale, and rising with peculiar steepness out of the sea,—give a character to the Spitzbergen scenery highly striking, interesting, and indeed magnificent.

"As soon as we passed to the northward of Cloven Cliff, the north-western land of Spitzbergen, the whole of the northern coast was seen through a highly and unequally refractive medium. In consequence of this, the cliffs were reared to an uncommon altitude, and presented the beautiful basaltic character, which it is a general property of this remarkable state of the atmosphere to produce. The apparent columns were all vertical, or nearly so, and, when slightly waved, maintained their parallelism, the curvatures of the adjoining columns corresponding with each other." P. 26, 27.

In the passage from Liverpool to this station, only the usual birds of the latitudes passed, which are enumerated, were met with *. They now continued to approach the Pole, in a sea clear of ice to the NW. and W., until one in the morning of Sunday the 28th, when, in Latitude 80° 30', they were stopped by the main northern ice. In the afternoon of this day it fell calm.

* *Procellaria pelagica*, near Harris; *Pelecanus bassanus* off Faroe; *Procellaria glacialis*, from Harris to Greenland; *Larus rissa*, *parasiticus*, *glaucus*, *eburneus*, were frequent: on approaching Spitzbergen, *Alca alle*, *Colymbus grylle*, *C. troile*, *Sterna hirundo*, *Emberiza nivalis*, &c.

Snow began to descend, and the mercury in the barometer sunk to 29° 40′, thus announcing a gale, which speedily followed. Next morning the wind moderated, and a heavy fall of snow commenced. This circumstance, with a low state of the barometer and a heavy sea, indicated a renewal of the gale from another quarter. The wind chopped round to the northward, and it presently blew very hard. This sudden change of the wind occasioned a great decrease of temperature; for in the space of sixteen hours, the thermometer sunk from 32° to 0° —2°, being a fall of 34°, the most remarkable range of temperature ever experienced by Captain Scoresby in the Greenland seas. On the 30th April, when the sun broke through the clouds, a change of temperature was produced from 3° or 4° below zero, to + 14°; and further, the side of the ship on which the sun shone was heated to 90° or 100°, and the pitch about the bends became fluid. Thus, while on one side there was uncommon warmth, on the opposite was great cold.

On the 1st May, at 5 A. M., Captain Scoresby calculated that he had advanced to 80° 34′, a distance of only 566 miles from the Pole; but the increasing accumulation of ice to the northward, and the want of whales, did not encourage further sailing in that direction. They were now within a short distance of the extreme accessible point of the Greenland ice towards the north; "and the Baffin," says Captain Scoresby, "was, without question, in the highest latitude of any ship at that moment on the sea; and there was no doubt on my mind, when I stood on the taffrail, as the ship was turned before the wind, that I was then nearer to the Pole than any individual on the face of the earth." They continued cruising amongst the ice under various latitudes in search of whales; and the first was captured on the 6th of May, in Latitude 79° 31′ N. On the 9th of May the cold was intense being —8°, the greatest degree of cold experienced by Captain Scoresby during twenty voyages to Greenland.

"Though we had smooth water, and kept the companion-door constantly closed, the cabin became more uncomfortable than the deck. Water spilt on the table, within three feet of a hot air-stove, became ice; washed linen became hard and sonorous; and mitts that had been hung to dry exactly in the front of the fire (the grate being full of blazing coals), and only thirty inches distant, were partially frozen; and even good ale, placed in a mug at the foot of the stove, began to congeal! A damp hand applied to any metallic sub-

stance in the open air stuck to it; and the tongue brought into contact with the same, adhered so firmly that it could not be removed without the loss of the skin. Some of the sailors suffered considerably from partial frost-bites. The cooper had his nose frozen, and was obliged to submit to a severe friction with snow; and the boatswain almost lost his hearing." P. 43, 44.

On the same day several parhelia or mock suns were seen. The nautical operations of this day were of the most difficult kind which the whale-fishers have to encounter, and in which numbers of ships are annually damaged. The following passage affords abundant proof of the great importance of the Greenland fishery, in forming active, ready, and experienced seamen.

"Most of the masses of drift-ice, among which we had to force a passage, were at least twenty times the weight of the ship, and as hard as some kinds of marble; a violent shock against some of them might have been fatal. But the difficulties and intricacies of such situations, affording exercise for the highest possible exertion of nautical skill, are capable of yielding, to the person who has the management of a ship, under such circumstances, a degree of enjoyment, which it would be difficult for navigators, accustomed to mere common-place operations, duly to appreciate. The ordinary management of a ship, under a strong gale, and with great velocity, exhibits evolutions of considerable elegance; but these cannot be comparable with the navigation in the intricacies of floating-ice, where the evolutions are frequent, and perpetually varying,—where manœuvres are to be accomplished, that extend to the very limits of possibility,—and where a degree of hazard attaches to some of the operations, which would render a mistake of the helm, or a miscalculation of the powers of the ship irremediable and destructive." P. 46, 47.

On May 16th they got *beset* in the ice; and this period of leisure afforded our author an opportunity of carrying into effect some magnetical experiments, of which an interesting account is given, from page 52 to 60 *.

On Monday, the 20th, the ice began to move; and, after sixteen hours constant exertion, the ship succeeded in reaching a free and open navigation. Having met with little success in fishing in these high latitudes, they now sailed southward, to what is called the *West Land Fishing-Ground*, extending from Lat. 77° downwards, where, within these last three or four years, the only good cargoes had been obtained. On the 23d May they reached Lat. 74° 43′ N., being the parallel where they pro-

* We are reluctantly compelled to postpone to next Number, a full account of all Captain Scoresby's Magnetical Experiments, and of his Magnetimeter and Chronometrical Compass.

posed to renew their search for whales. In this latitude they again entered the ice, pursuing a NW. and N. course; and on the 24th saw several whales, but captured none. On the 25th the ship encountered a heavy gale, of which an interesting account is given. For several days subsequently, the weather was generally foggy, with southerly and easterly winds. The temperature of the air being near to the freezing point, the fog was deposited on the rigging in a thin coating of transparent ice, so that the ropes, yards, &c. appeared as if made of ice. On the 30th, the ship was nearly beset; but next day a change of wind broke up the ice again. On the 1st June the ice was in such a state as to allow them to advance nearer to the land, and one whale was killed. On the 3d June many whales were seen, and one captured. On the 4th June they pushed still further towards the west, but were again confined in the ice until the 7th. During their besetment they saw many narwals, of which animal a curious account is given. An observation for the Lat. in June 5. gave 74° 18′. On the 6th, in the morning, all the rigging of the ship was thinly covered with a double fringe of snowy crystals, consisting of the particles of fog that had been deposited during the night on the opposite sides of the ropes, as they were successively presented to the wind, on the ship being repeatedly tacked. This appearance, with others of the same character, leads our author into a discussion in regard to the formation of snow-crystals; all of which, we may remark, are regular six-sided prisms, or modifications of that figure; and, therefore, belong to the rhomboidal series of crystallization. On the 7th of June, such finely marked *ice-blinks* appeared in the atmosphere, in connection with the horizon, as to present a perfect map of all the ice and openings of water for twenty or thirty miles around.

"The reflection was so strong and definite, that I could readily determine the figure and probable extent of all the fields and floes within this limit, and could distinguish packed or open ice, by its duller and less yellow image; while every vein and lake of water, producing its marked reflection by a deep blue, or bluish-black patch, amid the ice-blinks, enabled me to ascertain where the most water lay, and the nature of the obstacles that intervened. By this means only, I discovered a large opening immediately to the north-westward of the lake we had so long navigated, with a considerable expanse in the same direction, at a greater distance, bounded by sheets of ice that appeared to be of prodigious magnitude. This in-

duced me to examine the ice very closely in this quarter, when, in the very spot marked by the blink as being the narrowest, the ice was found to be in the act of opening, so as to permit our passing through towards the north-west. At the extremity of the first opening, or lake, there was a compact barrier of floes, wherein, however, after a few hours detention, we discovered a narrow dubious channel, that eventually conducted us into the expanse of water pointed out by reflection in the atmosphere." P. 80, 81.

The night of the 7th–8th, was stormy, with snow or fog; but in the afternoon the sky was clear, when land was discovered extending from N. by E. to NW., the nearest part supposed to be at the distance of fifty miles. This was the eastern coast of Greenland, being a continuation towards the north of that coast, on which the ancient Icelandic colonies were planted in the tenth century.

"I looked on it," says our author, "with intense interest, and flattered myself with the hope of being able to land upon some of its picturesque crags, where European foot had never trod, before the season for the fishery should come to a close. As no ship had ever before penetrated (I had reason to believe) within sight of this coast, at so early a period of the summer, I was encouraged to expect that my wishes would not be difficult to accomplish; and, as the main design of my voyage was fortunately compatible with researches about this unknown region, I determined immediately to penetrate, as far as possible, towards the shore." P. 82, 83.

Their latitude being 74° 6′, the southernmost land in sight was considered as the Hold-with-Hope of Hudson, and the most northerly as Gale Hamkes' Bay. On attempting to proceed to the northwest, they were interrupted by a solid barrier of fields and floes of ice, closely wedged together. They were therefore forced to remain until some change in the ice should take place. Captain Scoresby, in rowing amongst the ice, was struck with the numerous remarkable forms it assumed, and of which a particular account, illustrated with plates, is given in the Journal.

The ship still continuing beset, Captain Scoresby employed his leisure hours in making observations on the local deviation of the Baffin; and of which a highly curious and detailed account is given in the narrative. Early in the morning of the 11th June, during a perfect calm, the pressure in the floes relaxed, which enabled the ship to get nearer to the coast. On the 12th of June, the land being only ten or fifteen leagues distant, drawings were made of its appearance, and a set of observations on its bearings. The nearest approach to the land was about ten leagues; beyond that limit it was impossible to advance,

on account of the barrier of ice. The weather, however, was clear; and the coast, for an extent of ninety miles, was constantly visible; and the various headlands, owing to their great elevation, were strongly shewn; so that a tolerable survey was made of the more prominent parts of the coast. In carrying on this work, Captain Scoresby had already five or six stations determined astronomically, and had employed upwards of fifty angles or bearings. The general trending of this coast, extending from Gale Hamkes' Bay, in Lat. 75°, to Bontekoe Island and Hold-with-Hope, in 73° 30', is SSW., true. It is almost wholly mountainous and barren, and its ordinary height 3000 feet. Of this land, only a few points had been previously named; and, therefore, Captain Scoresby properly considered himself entitled to give names to the others; and hence we have Kater's Bay, Wollaston Foreland, Scott's Inlet (in honour of Sir Walter Scott), Home's Foreland, &c. In the midst of his operations for the survey of this coast, it fortunately happened that the moon, at a convenient distance from the sun, for determining the longitude, became visible, and this valuable opportunity was not lost. From six sets of distances and latitudes, he obtained the mean longitude of 17° 54′ 30″ W., for the place of the ship on the 14th June. These observations for the longitude, enabled Captain Scoresby to ascertain the exact effect in a particular case, of the extraordinary refractive property of the atmosphere in the Arctic Seas, which, without such proofs, would scarcely have been credible.

"The coast that has just been described, is in general so bold as to be distinctly visible, in the ordinary state of the atmosphere, at the distance of sixty miles; but on my last voyage into these regions, one part of this coast was seen, when at more than double this distance. The particulars were these:—Towards the end of July 1821, being among the ice in Lat. 74° 10′, and Longitude, by lunar observation and chronometer (which agreed to twenty-two minutes of longitude, or within six geographical miles), 12° 30′ 15″ W., land was seen from the mast-head to the westward, occasionally, for three successive days. It was so distinct and bold, that Captain Manby, who accompanied me on that voyage, and whose observations are already before the public, was enabled, at one time, to take a sketch of it from the deck, whilst I took a similar sketch from the mast-head, which is preserved in my journal of that year. The land at that time nearest to us was Wollaston's Foreland, which, by late surveys, proves to lie in Latitude 74° 25′ (the middle part of it), and Longitude 19° 50′: the distance, therefore must have been at least 120 miles. But Holme's Foreland, in 21[illegible]

W. Long., distinguished by two remarkable hummocks at its extremities, was also seen; its distance, by calculation, founded on astronomical observations, being 140 geographical, or 160 English miles. In an ordinary state of the atmosphere (supposing the refraction to be one-twelfth of the distance), any land to have been visible from a ship's mast-head, 100 feet high, at a distance of 140 miles, must have been at least two nautical miles, or 12,000 feet in elevation; but, as the land in question is not more than 3500 feet in altitude (by estimation), there must have been an extraordinary effect of refraction equal to 8500 feet. Now, the angle corresponding with an altitude of 8500 feet, and a distance of 140 miles, is 34′ 47″, the value of the extraordinary refraction, at the time the land was thus seen: or, calculating in the proportion of the distance, which is the most usual manner of estimating the refraction, it amounted to one-fourth of the arch of distance, instead of one-twelfth, the mean quantity.

"That land was seen under these circumstances there cannot be a doubt; for it was observed to be in the same position, and under a similar form, on the 18th, 23d, 24th, and 25th July 1821, when the ship was in longitude from 12° 30′ to 11° 50′ W., and on the 23d it remained visible for twenty-four hours together; and, though often changing its appearance, by the varying influence of the refraction, it constantly preserved a uniformity of position, and general similarity of character. In my journal of this day, I find I have observed, that my doubts about the reality of the land were now entirely removed, since, with a telescope, from the mast-head 'hills, dells, patches of snow, and masses of naked rock, could be satisfactorily traced, during four-and-twenty hours successively.' This extraordinary effect of refraction, therefore, I conceive to be fully established." P. 106—108.

A thick fog prevailed the greater part of the 15th June. On the 17th the weather was perfectly clear, and the land in sight all the day. As they advanced southward, some additional headlands were discovered, and the bearings of them taken. The Latitude at noon was 73° 17′, Long. 17° 40′ W. On the 18th, an opportunity again offered of prosecuting the surveys, and some additional bays, headlands, and islands, appeared in sight, but the distance was too great for getting their accurate outline. One of these we observe named Cape Franklin, in honour of the distinguished leader of the Arctic Land Expedition, and others, in compliment to Freycinet, Humboldt, &c. The Latitude, at noon, was 73° 1′, Long. 18° 1′ W. On the 19th June the weather was calm and clear, and the sun warm and most oppressive. The sea reflected objects as accurately as a mirror, from its unruffled surface.

"The strong action of the sun's rays soon produced such an unequal density in the atmosphere, that some of the most extraordinary phenomena to which this circumstance gives rise were exhibited.

The land, to appearance, was suddenly brought fifteen or twenty miles nearer us; its boldness and clearness, as seen from the deck, being superior to what its elevation and distinctness had previously been as seen from the mast-head. The ice about the horizon assumed various singular forms:—hummocks became vertical columns,—floes and fields arose above the horizon, like cliffs of prismatic-formed spar,—and, in many places, the ice was reflected in the atmosphere at some minutes elevation above the horizon. The ships around us, consisting of eight or nine sail, presented extraordinary characters. Their sails and masts were strangely distorted. Sometimes the courses would be depressed to almost nothing; the topsails expanded to near four times their proper height, and the topgallant-sails truncated. Occasionally a very odd spectacle occurred; an additional sail appeared above the topgallant-sail, like a royal hanging loose; and sometimes the expanded topsail, divided into two distinct sails, by the separation of all the additional height given by the refraction, which, slowly rolling upward, as it were, like the lifting of a curtain, dispersed, and became invisible, after leaving the mast-head. Above some distant ships, there was an inverted image in the air, many times larger than the object itself: this, in some instances, was at a considerable elevation above the ship; but it was found to be of a less size whenever the original and the image were not in contact. The image of one ship was distinctly seen for several minutes together, though the object to which it referred was not in sight! One ship was crowned with two images; the first an inverted one, and the second, a circumstance I never before observed, in its proper position. Altogether, the shipping, and other objects around us, presented a most amusing spectacle. They were perpetually changing their appearance, and afforded me abundant entertainment for hours together. The most remarkable effect produced, was on the most distant objects, the interesting appearances of which not being discernible without the use of a telescope, probably escaped general observation." P. 117–119.

The days of June 21, 22, and 23, were employed in the active pursuit of whales, but without success; and here an interesting account is given of the loss of one of the harpooners, who got entangled in one of the lines, and was hurried from the boat into the depth of the ocean, with the velocity of a cannon ball. On the 25th a whale was harpooned. It took 960 fathoms of line from the "fast-boat," was re-struck, and killed, after an interval of three hours. On the 26th of June, the whales having left them, they proceeded to the westward in search of them, into a large clear opening, several leagues in breadth. In beating through the ice to reach the opening, irregular alternations of blue and turbid-green water were observed on every tack the ship took. In the evening, they again approached nearer to the land, being in Lat. 71° 9′, Long. 18° 48′ W., and obtained a

series of bearings of the coast, and a sketch of about ninety miles of coast. On the 29th a narwal was killed, and the crew were actively employed until the 3d July, in the pursuit and killing of whales and narwals, and many curious details are given in the Journal, in regard to the habits, manners and structure of these remarkable animals. The whales having disappeared, they now cruized about in different directions amongst the ice. An immense quantity of the Little Auk flew past the ship, to the west. For many hours successively, perhaps from one to three flocks, consisting, on an average, of about two or three hundred birds, passed them in the minute, all flying in the same direction. It was calculated that near *half a million* of these birds appeared within sight in the course of twelve hours.

On the 5th, they were in Lat. 71° 7′, Long. 18° 40′ W. On the morning of the 9th, the atmosphere was in a highly refractive state, concerning which many interesting statements are given in the Journal; and the latitude, in the afternoon of this day, was 72° 10′ N. Early on the morning of the 15th July, a whale was captured, and many details are given in regard to the anatomical structure and physiology of these colossal animals. During the twenty days preceding the 15th July, about three-fourths of the time was foggy; and the facts stated in the Journal lead to an explanation of the extraordinary prevalence of foggy weather in the polar seas, and an investigation of the causes of the arctic fogs, which Captain Scoresby is inclined to consider as caused by the damp air near the level of the sea being cooled by contact with, or radiation from, the ice, which occasions a condensation of that proportion of moisture which the diminished temperature prevents the air from retaining. About midnight of the 16th, they fell in with a large ice-field, along the edge of which they coasted for six or eight hours, and accomplished a distance of thirty or forty miles. This field could not be less than thirty miles in diameter, and probably contained a surface of 700 or 800 square miles in a single sheet! They were now in Lat. 72° 33′, Long. 19° 8′ 45″ W. The land was in sight from NNE. to NNW., and filled up the interval not before seen, and enabled Captain Scoresby to determine the general position and tendency of the coast, from Lat. 75°,

down to Lat. 70°. No whales appearing, they again sailed to Lat. 71°. On the 16th, 17th, and 18th July, numerous interesting displays of atmospheric refraction were observed, for the description of which, and the ingenious speculations regarding their formation, we must refer to the Journal itself.

Their endeavours to find whales, at a distance from the coast, having failed, Captain Scoresby considered himself fully justified in approaching nearer to the shore; and, on the 19th July, they came close to the land at the mouth of a bay, in Lat. 71° 2′. On the 20th, they got within six or seven miles of the coast, which afforded an opportunity for various surveying operations. At noon, the latitude observed was 70° 44′ 57″ N., Long. 21° 9′ W. The land at this time surveyed, including fifteen miles of coast to the southward, and twenty-five to the northward, was rugged, black, and barren, and the general height of this coast about 3000 feet. On the 24th July, they again approached the land, when the sky became clear.

"Being anxious to land upon a coast, on which no navigator (a whale-fisher or two perhaps excepted) had ever set foot, I thought this a favourable opportunity for gratifying my curiosity. This curiosity was heightened almost to the utmost pitch, by the historical recollections of the Icelandic colonies, that had, at a remote period, been planted a few degrees to the southward, upon the same line of coast,—and particularly by the hope which I could not avoid indulging, that I might be able to discover some traces of those hardy people, the fate of whom, for near four centuries, has been a problem of such intense and almost universal interest. An additional interest attached to the investigation of this country (if the interest excited by the above considerations were capable of augmentation), was the circumstance of the singular and total failure of the many attempts of the Danes to reach this coast, for the recovery of the ancient colonies,—together with the peculiar enjoyment that necessarily arose out of the conviction, that the shore on which I designed to land was entirely unknown to Europeans, and totally unexplored." P. 183, 184.

They stood in, and landed on a rocky point, named Cape Lister, lying in Lat. 70° 30′ N., and Long. 21° 30′ W. The rugged rocks of this point were primitive, and the vegetation was confined to a few lichens, with occasional tufts of *Andromeda tetragona*, *Saxifraga oppositifolia*, *Papaver nudicaule*, and *Ranunculus nivalis*. Here the remains of Esquimaux huts were discovered, and fire-places with ashes, thus intimating, that the inhabitants may have been in this quarter within a few weeks of

the time of landing. On returning to the ship, after the first landing, many curious effects of atmospheric refraction were observed. One is so interesting, and brings so strongly to our recollection the boasted powers of the *beacon-keeper* of the Isle of France, that we cannot refrain from communicating it to our readers.

"The most extraordinary effect of this state of the atmosphere, however, was the distinct inverted image of a ship in the clear sky, over the middle of the large bay or inlet before mentioned,—the ship itself being entirely beyond the horizon. Appearances of this kind I have before noticed, but the peculiarities of this were,—the perfection of the image, and the great distance of the vessel that it represented. It was so extremely well defined, that when examined with a telescope by Dollond, I could distinguish every sail, the general "rig of the ship," and its particular character; insomuch that I confidently pronounced it to be my Father's ship, the Fame, which it afterwards proved to be;—though, on comparing notes with my Father, I found that our relative position at the time gave our distance from one another very nearly thirty miles, being about seventeen miles beyond the horizon, and some leagues beyond the limit of direct vision. I was so struck by the peculiarity of the circumstance, that I mentioned it to the officer of the watch, stating my full conviction that the Fame was then cruizing in the neighbouring inlet." P. 189, 190.

On the 25th passed Cape Tobin, the southernmost headland of the coast just surveyed. About five leagues to the westward of this cape, that is further up the inlet, a new coast appeared, having a different form from any hitherto met with, and which was named Jameson's Land. The south side of the inlet is mountainous, and is terminated to the eastward by a bold narrow promontory, which was named Cape Brewster. A second landing was made at Cape Hope (so named in compliment to S. Hope, Esq. of Everton), where a series of angles and bearings for the advancement of the survey was taken. Some whales having made their appearance, Captain Scoresby was encouraged to prolong his stay in this quarter, which afforded him an opportunity of visiting the shore, on a more interesting spot than formerly, on the east side of Jameson's Land. The place selected for landing upon was Cape Stewart, so named in honour of Professor Dugald Stewart. The appearance of the country all around was totally different from any of the other parts of the coast already visited,—they being of primitive rocks, whilst in Jameson's Land, as far as examined, all the rocky masses were of the coal formation. The latitude, this day, was 70° 25′ N.,

Long. 22° 21′ 45″ W. The great inlet already mentioned was named Scoresby's Sound, in compliment to Mr Scoresby *senior*, one of the most active and skilful navigators of the Greenland Sea; and our readers, we are sure, will do justice to the feeling and delicacy of the following remarks:

"Very little assistance was hitherto afforded me by any individual, in the investigation of these regions; but where any valuable information had been received, I considered it incumbent on me to compliment the person whose researches had been useful to me, by applying his name to the portion of land, or sea, respecting which he had supplied the information. Agreeable to this practice, I could not, without evident injustice, overlook the very important researches of my Father in this inlet,—who not only was, I had reason to believe, the original discoverer of it, but who was the first navigator who entered it, and determined its general position, and who, with a peculiar perseverance, sent his boats and examined two of its extensive ramifications, to a distance of sixty miles from the extreme capes, or entrance of the inlet. As such, after some scruples of delicacy, lest it should be considered as bordering on self-compliment, I ventured to name this capacious inlet, in honour of my father, Scoresby's Sound." P. 196, 197.

After a description of Scoresby's Sound, we have an account of another landing on the coast of Cape Hope. Here traces of inhabitants, in the remains of huts and tumuli, resembling those before observed, were met with. Fragments of the horns of rein-deers, with human bones, and those of dogs, were collected. The skull of a dog was found in a small grave, probably that of a child, as Crantz informs us, that the Greenlanders lay a dog's head by the grave of a child, considering that, as a dog can find its way every where, it will shew the ignorant babe the way to the land of souls. Few living creatures were to be seen, excepting insects; scarcely any birds, and the only quadruped met with was the white hare (*Lepus glacialis*). The insects were numerous, consisting of mosquitoes, and several species of butterflies. The heat amongst the rocks was oppressive, and the temperature about 70° Fahrenheit. In the account of Jameson's Land, which follows, a description is given of the fine section of the coal formation at Neill's Cliffs; and also of the numerous traces of inhabitants, some very recent, seen in the neighbouring district. One hamlet consisted of nine or ten huts. The roofs in all the huts had fallen in, or had been removed, on account of the wood of which they are composed; what remained

consisted of an excavation in the ground, at the brow of a bank, about four feet in depth, fifteen feet in length, and six or nine in width. The sides of each were supported by a wall of stone, and the bottom appeared to be gravel, moss and clay. The access to these huts was a horizontal tunnel, perforating the ground, about fifteen feet in length, opening at one extremity on the side of the bank, into the external air; and, at the other, communicating with the interior of the hut. The funnel was roofed with slabs of stone and sods, and was so low, that a person must creep on hands and feet to get into the dwelling. The admirable adaptation of this kind of dwelling to the nature of the country, and the circumstances of the inhabitants, is thus described by our author:

"I was much struck by its admirable adaptation to the nature of the climate, and the circumstances of the inhabitants. The uncivilized Esquimaux, using no fires in these habitations, but only lamps, which serve both for light and for warming their victuals, require, in the severities of winter, to economise, with the greatest care, such artificial warmth as they are able to produce in their huts. For this purpose, an under-ground dwelling, defended from the penetration of the frost by a roof of moss and earth, with an additional coating of a bed of snow, and preserved from the entrance of the piercing wind, by a long subterranean tunnel, without the possibility of being annoyed by any draught of air, but what is voluntarily admitted,—forms one of the best contrivances which, considering the limited resources, and the unenlightened state of these people, could possibly have been adopted. The plan of the tunnel is ingenious. It always has its opening directed to the southward, both that the meridian rays of the spring and autumn sun may pierce it with their genial warmth, and that the north, east, and west winds, whose severity must be most intense, may blow past without penetrating. In some cases, the bottom of the tunnel is on a level with the floor of the hut; but, in others (when there is, perhaps unwittingly, a practical application of a scientific principle) the tunnel is so much below the hut, that the roof of the former coincides with the floor of the latter. On this plan, the cold air which creeps along the tunnel, being denser than the air in the hut, can have no tendency to rise into it, but the contrary, unless a circulation were intentionally encouraged, by allowing the escape of the warm air from the windows or roof. In general, it appears, that the interchange of air must be effected by the slow and almost imperceptible currents passing and repassing in the contracted tunnel." P. 209, 210.

Adjoining the huts were remains of stores and other offices, and also many graves. Numerous pieces of rein-deer's horns were found, also bones of seals, walrusses, bears, dogs, narwals, and whales, and the thigh-bones of an animal. the species of

which could not be determined. The number of inhabitants, Captain Scoresby remarks, that have, at no distant period, resided in Jameson's Land, must have been very considerable, since the remains of huts, with graves, were found all along the shore, in almost every place suitable for their erection. The vegetation in this land was considerable, the ground in some places being clothed with grass a foot in height, and here were collected *Ranunculus nivalis*, *Saxifraga cernua*, *S. nivalis*, *Eriophorum capitatum*, *Epilobium latifolium*, *Dryas octopetala*, *Papaver nudicaule*, *Rhodiola rosea*, with creeping dwarf willows, &c. A new species of mouse, allied to the Lemming, was caught; brent-geese, plovers, ptarmigans, &c. were observed; several butterflies, and some bees and mosquitoes, were collected. Captain Lloyd of the Trafalgar sailed in his boat up Hurry's Inlet, for twenty miles, along the coast of Jameson's Land, and landed on one of the promontories, where he found the heat as oppressive to his feelings as the climate in the East or West Indies. It so overcame his men, who had attempted to ascend an adjoining hill, that they could not proceed, but, lying down, fell fast asleep. The power of the sun was such, even in this high latitude, as to occasion violent inflammation of the eyes, which continued for several days. The mosquitoes, which were very numerous, likewise added to the inconvenience they suffered from the heat, by biting them with great severity. The effect of the heat on the ground was such, that the dry turf was easily lit with a match, and afforded a ready fire.

After describing the wild and striking country, extending from Cape Brewster up Scoresby's Sound, the Journal again proceeds. The coast was next examined down as low as Lat. 69°. A little before midnight of the 29th July, the sea froze all over, though the thermometer never sank below 31° Fahr. at the height of the deck. The sky being clear, and the sun in the horizon, the effect was ascribed to radiation. A curious optical deception occurred, when the sun was just about setting, respecting the distant objects. Seeing a piece of ice at the apparent distance of two or three miles, on which there was a great load of rocks, a boat was dispatched to procure some specimens. To the surprise of the people in the boat, they rowed hard for two or three hours before they reached it, when the

mass of ice that had appeared to be only a few feet high, under the erroneous idea which had been formed of its distance, proved to be higher than a ship's mast-head. On the 30th of July, being now nearly 2° of latitude farther south than the lowest parallel in which Captain Scoresby had ever pursued the whale-fishery with success, and being disappointed in his expectation of finding whales, he determined to make researches for whales in other quarters. He now, therefore, bore away to the eastward, with the view of doubling the chain of floating icebergs off Cape Brewster. Their number proved to be more considerable than had been expected. One of them was a mile in circumference, and 100 feet above the level of the sea, and the estimated weight of this *floating mass* was 45 millions of tons! On the 31st July, they continued their course to the north-eastward, skirting the western edge of the ice: the Lat. at noon was 70° 25′ N., Long. 19° 11′ W. An angle of the highest peak of Roscoe mountains, taken in passing them at a considerable distance, gave the height of 4370 feet,—the altitude of Ben Nevis, in Scotland. On the 6th August, in Lat. 72° 7′, Long. 19° 11′, soundings were obtained in 118 fathoms. The temperature of the sea at the surface was 34°, and, within five fathoms of the bottom, by a Six's thermometer, it was 29°. The air at this time was 42°. In all former experiments on the temperature of the Greenland Sea, Captain Scoresby invariably found it to be warmer below than at the surface,—facts which lead to some further interesting observations which we cannot spare room for noticing. The neighbouring floating ice-bergs and ice-fields offered opportunity for new observations and views in regard to their formation. Mention is made of ice crystallised in cubes, rhomboidal dodecahedrons, rhomboids, and prisms. But here there must be some oversight: there can be but one primitive form in ice,—in this case the cube or rhomboid,—and we have no doubt that the rhomboid is the primitive form; and, therefore, that the supposed cube and rhomboidal dodecahedron would have proved, on more accurate investigation, to be forms of the rhomboidal series.

Having failed in falling in with whales, they again stood in for the land, and got close in with the shore and abreast Traill Island, (named in compliment to Dr Traill, a distinguished

physician and naturalist in Liverpool). A landing was effected here, and very numerous relics of the natives were met with. On one flat of land, to the eastward of Cape Simpson, they observed several dozens of old huts, and ground-plots of summer tents. A lamp, of the kind commonly used by the Esquimaux, was picked up by one of the Trafalgar's sailors; numerous pieces of the keels of sledges were collected, intimating not only that the inhabitants had once been very numerous there, but that they must have made great use of their sledges, to afford so many pieces of these half worn defences for the keels. There were remains and bones of rein-deer, dogs, narwals, seals, bears, about the old hamlets they visited, and these in very great abundance. The vessel was nearly lost in this quarter during a violent gale. The long and tedious gale which commenced blowing NE., on the night of the 13th of August, and the rain which had fallen in an incessant and heavy shower, that lasted for sixty-two hours, at length abated. The quantity of rain that fell far exceeded any thing of the kind ever observed by Captain Scoresby. The boats were likely to be torn from the tackles, by the weight of the water that collected in them before it was observed, and after they were repeatedly emptied. The survey was continued along the coast, and various headlands, bays, and islands, noted and named. A distant tract of mountainous country was seen across the interior of Davy's Inlet (so named in honour of Sir Humphry Davy): but it appeared to be insular. To the westward of this island, there is a chain of the most elevated mountains hitherto met with during this survey. This chain, named Werner Mountains, from respect to the memory of the celebrated geologist, is distinctly seen at the distance of between thirty and forty leagues, in the ordinary state of the atmosphere, and is so bold as to give to the mountainous coast before it the appearance of low hummocky land. Many very beautiful and interesting haloes made their appearance, and pages 273. to 284. are occupied with descriptions of these, and speculations on their mode of formation. During the six preceding weeks, the search for whales proved almost wholly unsuccessful. The land had already assumed its winter covering of snow,—the sea began to freeze in the evenings, and the gloom of the lengthening night marked the approach of winter,

and intimated that the fishing season was nearly at a close. The only hope of additional success depended on their vicinity to the coast. The resolution of remaining proved a fortunate one, for, on the 15th August, three large whales were captured.

On the night of the 15th and 16th, stars were seen for the first time during fifteen weeks; the sky became beautifully clear, the sea, as usual on such occasions, began to freeze as soon as the sun descended within 4 or 5 degrees of the horizon, though the temperature was invariably above the freezing point of sea-water, an effect which, Captain Scoresby remarks, may be ascribed to the cooling of the surface of the water, by the effect of radiation between the surface of the sea and the atmosphere. The fact of the abstraction of the heat of the water, when exposed to the full aspect of a colourless sky, is certain; but, in cloudy weather, no freezing of the sea ever takes place, when the temperature is above 29°; but, in clear and calm weather, the sea generally freezes on the decline of the sun towards the meridian below the pole, though the temperature be 32° or higher. In the instance now alluded to, the freezing commenced when the temperature was 36°, being 7½° or 8° above the freezing point of sea-water. On the 20th August the weather cleared, and allowed the survey to be continued. The Latitude at mid-day was 71° 50′ 28″, Longitude 20° 43′ 15″ W. Various headlands were named, in honour of distinguished naturalists and navigators, as Capes Brown, Krusentern, Buch, &c. Mr Scoresby *senior* visited his son in the afternoon of this day, and gave an account, published in the Journal, of the interesting adventures of the crews of two of his boats, who were absent nearly forty hours during the severe storm of the 12th and 13th. On the 25th August the survey was terminated. The great hazard they encountered on the storm of the 23d, with numerous symptoms of approaching winter, warned them to quit a coast which was daily becoming more and more dangerous. In the early part of this month they experienced the heat of a British summer, and numerous birds were seen,—but the land was now covered with snow, and the birds were moving off to their southern quarters. Another intimation of approaching winter, to which they had been little accustomed in the Greenland Fishery, was the setting of the sun, and the rapid

shortening of the days: On the 2d of the month it was observed that the sun was above the horizon at midnight; but now they had, 7 hours 36 minutes betwixt sun-setting and sun-rising, with an increase of 10 minutes in the length of each succeeding night. Hence the shortening of the days was so rapid, as to be almost perceptible between one day and the next, without the use of a watch; added to the gloom common to the night, in the absence of the moon, the darkness was much increased by the deep and thick fog. It was therefore determined to leave the coast, and proceed homewards,—a determination which was acted upon in the evening of this day.

In the 12th chapter of the Journal, which follows, there is an interesting retrospective view of the researches made upon the eastern coast of Greenland, shewing that the extent of coast surveyed was about 800 miles. The errors of former charts are pointed out,—the general characters of the coast delineated,—and, from a comparison of the inlets on the newly discovered coast, with those on the west coast, mentioned by Sir Charles Gièsecké, it is inferred *that Greenland is probably a great group of islands*. The productions of the country are next enumerated, —and a full statement of the characters of the relics of the human inhabitants lead to the inference, that its population is Esquimaux, with an intermixture of Europeans, probably of the ancient colonies planted by the Icelanders.

" Hence, there is some reason to believe that these colonies were not entirely depopulated,—that they are not yet extinct; though it is more than probable that such of the colonists as outlived the 'black-death,' and the privation they must have suffered, when their supplies were cut off, as it is said they were, by the descent of the polar ice, would cease to be a distinct people;—for being then reduced to the necessity of following the occupation of the Esquimaux, and of copying their manners, they would probably become gradually incorporated with the aborigines, until few traces of their original civilization remained.

" The very extraordinary circumstances connected with these colonies of Icelanders, as regards their original planting,—flourishing condition,—reception of Christianity,—and their total separation from the world, since the beginning of the fifteenth century;—and the very important question respecting their fate, to which their early history gives rise, rendered researches for inhabitants on this coast an object to me of the most intense interest. Hence, it may readily be conceived what was the nature of my disappointment, when, on descending to the latitude of 69° 30′, where I was only at

the distance of about seventy leagues from the site of the northern colonies, as given by Crantz, the main interests of my voyage obliged me to put about, and return to the northward. This disappointment was the greater, since I could observe no other hinderance to my penetration along the coast. I had reason, indeed, to believe, that, could I have been justified in devoting three or four weeks of my time entirely to research, I might have coasted the land down to Cape Farewell, and seen every station of the colonies by the way. In such an investigation I apprehended little difficulty. The chief difficulty, that of obtaining an entrance through a body of ice, 100 to 150 miles in width, which skirted and defended the coast, was already overcome; and as, in the 70th, 71st, and 72d parallels of latitude, we found the best navigation close in-shore, we had some reason to expect that we should not, at any rate, have met with any thing insurmountable to obstruct our way to the southward, even down to the extreme promontory of Greenland." P. 337-339.

We deeply regret that the nature of Captain Scoresby's engagements forced him to abandon the investigation of the country along the line of coast where the Icelandic colonies were planted. Now, however, since the way has been opened by his investigations, we trust another season will not elapse before this interesting country is examined, down to Cape Farewell, by our author himself, and also by ships sent out by the Governments of Britain and Denmark.

On the 30th August they got clear of the ice, on which occasion the following excellent remarks are given.

"It is not easy for a person, unacquainted with the navigation of the polar seas, to judge of the perpetual anxiety that the commander of a ship suffers, while involved among the crowded, extensive, and dangerous ices with which these regions abound. Among drift-ice, whenever the wind is high, ships are liable to receive blows that might be destructive; and, among fields and floes, when the weather is thick, so that the dangers of the navigation cannot always be discerned before it is too late, they are exposed to the closing of these irresistible masses of ice upon them, which are capable of crushing them in pieces in a moment. Ships under-way are almost perpetually exposed to one or other of these dangers; nor are ships moored to the ice by any means in safety, as our experience this voyage too powerfully demonstrated. Where floes abound, they are almost continually revolving and driving about in various directions, and frequently coming into mutual contact, with tremendous concussions. Different causes operate in bringing separate masses into contact, the combined influence of which is often altogether incalculable. Thus, superficial currents, which are not uncommon, operate more powerfully upon light ice than heavy ice, so as to carry the former with greater velocity than the latter. The wind also,

which acts upon all ice, and gives it a universal tendency to leeward, operates more powerfully on light and hummocky ice, than on heavy and flat ice, so that the two former descriptions drift faster than the two latter. This general tendency of the ice is modified by the influence of other ice in connection or contact with it, also by the different forms which the sheets of ice assume, and by the position in which they lie, in reference to the wind. For instance: while circular sheets of ice, or sheets having a regular polygonal form, generally drift directly "before the wind,"—oblong pieces pursue a medium course between that of the direction of the wind, and the point to which the leeward extremity of their longest axis is directed. Hence it is evident, that the united effect of these various causes influencing 'the set of the ice,' can never be fully anticipated; although long experience, in navigating the polar seas, will enable a person of observation, in most cases, to form a tolerably correct judgment of the safety or danger of almost any situation. Such being the anxieties and dangers attendant on the navigation among the northern ices, the relief that the captains of the whalers experience, when they get clear out to sea, must be in some degree appreciated. My father has been heard to express his feelings on this subject, when fairly at sea, with the characteristic observation, that *his watch was out*." P. 349, 350.

On Sunday, September 1st, the sea was observed coloured in veins or patches, of a brown colour, or sometimes with a yellowish green; and this water, on being examined by the microscope, appeared swarming with minute marine animals. A drop of this water contained 26,500 animalcules. Hence, reckoning sixty drops to a dram, there would be a number in a gallon of water, exceeding by one-half the amount of the population of the whole globe. It affords an interesting conception of the minuteness of some tribes of animals, when we think of more than 26,000 individuals living, obtaining subsistence, and moving perfectly at their ease in a single drop of water. "A whale," says our author, "requires a sea, an ocean to sport in; about a hundred and fifty millions of these minute creatures, would have abundant room in a tumbler of water."

On the 3d September they experienced a severe gale. On the 5th came in sight of Myngeness, the most western of the Faroe Islands. The phenomena of the clouds in the high cliffs of Kalsoe and Osteroe, lead our author into an interesting speculation in regard to the formation and suspension of clouds, which we regret our limits prevent us noticing at present. At 6 A. M. of the 9th September, they made land, which proved to be the Butt of the Lewis. The weather had a troubled aspect,

—the storm rose and continued to the 11th, when it raged with great violence during the whole day. The account of the storm is one of the most interesting relations in this interesting volume. Captain Scoresby expresses strongly his feelings of gratitude, for his preservation during these terrible scenes of danger. On the 14th September, the sun exhibited a curious appearance at setting. A little before the lower limb had descended to the horizon, it became suddenly elongated downwards, in the form of a prodigious ball of fire. This appearance occurred when the sun was directly in a line with Inisterhol on the coast of Ireland, which not only eclipsed the light upon this island, but emblazoned it with the most splendid luminary of our system. In their progress southward, the arrangement of the light-houses, on different points of the coast, gave rise to some excellent remarks on the necessity of regular, systematic, and easily intelligible descriptions of them, for the use and safety of mariners.

The Baffin reached Great Orme Head on Wednesday the 18th September, and speedily afterwards Liverpool.

The Journal is succeeded by a valuable and interesting Appendix, consisting of nine different articles. No. 1. List of Specimens of Rocks brought from the Eastern Coast of Greenland, with geognostical remarks by Professor Jameson. No. 2. List of Plants, from the East Coast of Greenland, with some remarks by Dr Hooker, Professor of Botany, Glasgow. No. 3. List of Animals met with on the Eastern Coast of West Greenland, with notes and memoranda, by Professor Jameson and Dr Traill. No. 4. Meteorological Table, including the daily latitude and longitude of the ship. No. 5. Journal of Proceedings on board of the Hercules of Aberdeen, on the Coast of Greenland. This journal is valuable to the whale-fisher. It gives an account of the capture of whales at a very late season of the year, and includes some important observations on the dangerous nature of the East Coast of West Greenland, as a fishing-station, at the end of summer. It also includes an account of the sufferings by some of the crew of the ship King George.

" The crew of the King George, it appears, struck a fish during one of those severe gales which we had in the month of May, when the thermometer fell to zero or below. Thick weather setting in, the boats lost sight of the ship, and were exposed to the severities of

the most intense cold and violent storm, for fifty hours. One man fell a victim to the cold while on the ice, and another died soon after he reached the ship. All of them suffered from the severity of the exposure more or less. Some lost their fingers,—others their toes, —some their hands,—and others their feet. The surgeon of the King George told Mr Gibson, surgeon of the Trafalgar, who supplied him with some dressings, that he had amputated thirty-five fingers and toes in one day! An example was given of the severity of the cold, by one of the King George's sailors, who stated, that a quantity of beef that was sent in the boats to the men upon the ice, when they first saw them, was taken hot out of the coppers; but before they reached the ice, though at no great distance, it was frozen so hard, that they had to cut it in pieces with hatchets." P. 451, 452.

No. 6. Journal of Proceedings on board of the Trafalgar of Hull, on the East Coast of Greenland, from the 12th to the 31st of August 1822. Besides many valuable details, this journal contains the following very striking instance of escape from the dreadful perils of the ice. The crew of the Trafalgar, in the midst of appalling dangers, made various attempts to moor the ship to the ice. It was in an attempt of this kind that the interesting incident and escape took place, which is thus related in the journal.

"At 9 P. M. we made another attempt to moor the ship to a floe or field of ice. Five active men were sent to fix some anchors, and two warps were fastened to them. Two of the men in the boat returned for another anchor, and just as they got hold of the ship, both the warps broke that were fast to the ice; and the ship turning quickly round, received a dreadful shock on her quarter against the floe. This compelled us to stand out amongst the loose ice again; about an hour afterwards we returned, and sent a boat to endeavour to bring on board those unfortunately left on the ice. But the sea was so heavy that the men refused to risk themselves in the boat, and it returned without them. We now were obliged to reach off to the eastward, among the loose ice, to the distance of nearly twenty miles from the poor men on the floe. Here we had room to beat to windward. At midnight the wind veered to the eastward, and began to abate.

"*Saturday, 24th.*—Towards morning the weather cleared up, and the wind abated, on which we commenced a careful search for the five absent men, though with very small hopes of ever seeing them again. But, after standing four hours to the westward, to our great joy, we got sight of them with the glass from the mast-head, upon a small piece of ice, and at 8½ A. M. sent a boat and took all of them on board alive; and, considering the severities they had endured from cold, wet, and hunger, in better health than possibly could have been expected. The same hardships must have killed any one not accustomed to these regions. It was indeed a deliverance of the most extraordinary description. The account they gave of their perilous adventures, was to the following effect:

"Shortly after the departure of the boat which had attempted their resçue, a portion of the floe upon which they stood broke off by the action of the swell, and before they could step across to the main sheet, the water intervened and prevented their retreat. They soon drifted from beneath the shelter of the floe into a heavy sea. Almost every other wave now washed over the piece of ice, so that, to secure themselves, they were obliged to lie down flat on their bellies, and cling to the edge of the ice with their hands. In this state of dreadful suffering and danger, they remained until about midnight, when the mass of ice to which they clung was dashed by the waves against another lump, and broke into three pieces. They were fortunately on the largest part (which, however, was only a few yards in diameter), and on this they spent a dismal and hopeless night, frequently washed over by the sea, and in perpetual expectation that the next heavy wave would force them from their imperfect hold, and bury them in the deep. As soon as the sea began to fall, they contrived to stand upright, and to move about, so as to gain a little warmth. But this measure was likely to fail, when, on the clearing away of the mist, they were overwhelmed in despair, on finding there was no ship within sight. The Trafalgar, they now apprehended, had foundered in the gale, and if so, their situation was indeed without hope. The usual effect of severe exposure, in occasioning drowsiness, then began to make its appearance amongst them and one man expressed great desire to sleep, which, however, his companions very prudently prevented: otherwise, it is probable, he would have awoke no more. Soon afterwards they were rejoiced by a sight of the ship, whose approach gave some stimulus to their spirits, and enabled them to make that exertion which was necessary for preserving life, until they could be taken from their perilous situation." P. 459–461.

No. 7. is a Table of Latitude and Longitude of Headlands, Bays and Islands on the East Coast of West Greenland. No. 8. Remarks on the Structure of Greenland by Sir Charles Gièsecké, in which it is said, and in confirmation of Captain Scoresby's view, "That the whole coast of Greenland formerly consisted of large islands, which are now, as it were, cemented together, by immense masses of ice." And No. 9. contains useful explanations of some of the Technical Terms made use of in the course of the work.

Such, then, are the general contents of this very amusing, and highly interesting volume. The concluding general observations we had to offer on the value of the discoveries here communicated to the world, both in a commercial and scientific view, must be delayed for the present, as we have already much exceeded the limits prescribed for our article.

We trust, however, that the rapid view of the Journal contained in the preceding pages, will convey to our readers an adequate idea of its nature; and as we have made Capt. Scoresby describe the natural phenomena he witnessed, and state the speculations they gave rise to, and the difficulties and dangers he experienced, in his *own words*, we feel confident, that we do him perfect justice, and afford much more satisfactory and useful information to the public, than if we adopted the practice of throwing the author into the shade, by intruding our views and fancies in place of his facts and reasonings.

ART. XVI.—*Account of a Series of Electro-Magnetic Experiments, with Observations on the Mathematical Laws of Electro-Magnetism.* By PETER BARLOW, Esq., Royal Military Academy, Woolwich.

IN several of the preceding numbers of this Journal *, we have endeavoured to make our readers acquainted with the very interesting electro-magnetic investigations and experiments of Oersted, Ampere, Sir Humphry Davy, Professors Moll and Van Rees, Mr Faraday, and Mr Barlow.

The appearance of a second edition of Mr Barlow's very interesting Essay on Magnetic attractions, and on the Laws of Terrestrial and Electro-Magnetism, enables us to resume this important and curious subject, and to lay before our readers a series of the most popular and instructive experiments in this new science.

We were enabled, in a former number, Vol. VII. p. 281. to communicate an early account of Mr Barlow's general law, and of the Formula † which contained it; but as we gave only a brief notice of the apparatus which he added to Dr Hare's colorimotor, we shall now supply this defect.

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* See this *Journal*, Vol. IV., p. 167, 406, 435; Vol. V. p. 301, 352, 391, 392; Vol. VI. p. 83, 179, 220; Vol. VII. p. 281.

† This Formula was misprinted, it should have been Tan $\delta \mp \frac{\cos \varphi}{\cot \Delta + \sin \varphi}$

This part of the apparatus is shewn in Plate VII., Fig. 1., where "AB is an upright stand, placed near the poles of the battery; *a b*, *c d*, are two staples of stout copper-wire, driven into the upright, the two ends at *b* and *c* passing quite through, as shewn at C and Z; and on which two wires are fastened by spiral turns, and with which the communication is made with the poles of the battery; *e f*, *g h*, are two copper-wires of the same dimension as the staples, each four feet long, having their ends flattened and drilled so as just to enable them to slide freely upon the wires *a b*, *c d*, and the vertical wire *f h*, also 4 feet in length, which passes through a hole in the top of the table FGHI, and so tight as to render it perfectly fixed. On the plane of the table, which is two feet in square, the circle NESW is described about the centre *o*, and divided into the points of the compass and smaller divisions; NS, is an index or box-ruler, through which the wire *f h* passes, so that the former may be turned freely about the latter, and set to any proposed azimuth. On this ruler is placed the small compass *c'*, by means of which the deviation at any time may be taken; *c''* is another compass placed on the top of the support L *c''*, and is intended to remain fixed in its place, in order to serve as a standard for estimating and comparing the power of the battery at different times.

"For the principal experiments this apparatus is placed so that the plane of the rectangle of wires is perpendicular to the magnetic meridian; because in this position the horizontal wires being east and west, they have no effect in deflecting the needle from its direction (at least there is only one exception to this, which will be noticed hereafter), and consequently all the effect produced upon the needle during the rotation of the index in the circle NESW, is due to the vertical wire only, except so far as the horizontal wires may increase or diminish the directive power of the needle. This, however, in the cases to which we shall refer, is very inconsiderable.

"But in order that we may know precisely what part of the change of deviation between one situation of the compass and another is actually due to that change of position, recourse must be had to the standard compass, which, always remaining fixed

in its position, may be used as a constant indicator of the strength of the battery. But as the application of this measure to computation is involved in principles not at present explained, it will be proper first to inform the reader of the means which I employ in the first instance to preserve the uniformity of action during every separate course of experiments. These were as follows:—

"The vessel which contains the dilute acid, into which the plates are immersed, holds nearly twenty gallons; and I begin the experiments with little more than twelve gallons; moreover the plates are not, in the first instance, let down to their lowest point. The intensity shown by the standard compass after the connection has been made some minutes, is noted; and by breaking off and making the contact anew, this same intensity occurs again, the power being always strongest when the contact is first made; then when the standard compass returns to its former bearing, the observation with the other compass is taken; the contact broken, and renewed, and so on as long as the battery retains sufficient power. When this fails, the plates are lowered a little more, the power thus increased, and the observations resumed, till at length the plates being wholly down, and the power too weak, recourse is had to a supply of more dilute acid; by which means a tolerably steady action is kept up longer than is necessary for any series of experiments of this kind."

By means of this apparatus, Mr Barlow performed a series of experiments, in order to establish the law of the phenomena, and all his results harmonise in a very singular manner with the general principle, "*that every particle of the galvanic fluid in the conducting wire acts on every particle of the magnetic fluid in a magnetised needle, with a force varying inversely as the square of the distance; but that the action of the particles of the fluid in the wire is neither to attract nor to repel either poles of a magnetic particle, but a tangential force which has a tendency to place the poles of either fluids at right angles to those of the other; whereby a magnetic particle, supposing it under the influence of the wire only, would always place itself at right angles to the line let fall from it perpendicular to the wire, and to the direction of the wire itself at that point.*

Electro-Magnetic Experiments.

The following very interesting experiments are selected from Mr Barlow's section on this subject, the greater number of those which we have omitted having been previously given in this work.

Exp. I. *To exhibit the rotation of a galvanic wire round a magnet, and the reverse.*

Mr Faraday's first apparatus for this purpose, has already been given in Vol. VI. p. 178, and 223. and 224. Note. He afterwards invented another apparatus, requiring a less galvanic action, which is shewn in Fig. 2. Plate VII.

" It consists of a piece of glass tube, the bottom part of which is closed by a cork, and through it is passed a small piece of soft iron-wire, so as to project above and below the cork. A little mercury is then poured in, to form a channel between the iron-wire and the glass-tube. The upper orifice is also closed by a cork, through which a piece of platinum-wire passes, being terminated within by a loop; another piece of wire hangs from this by a loop, and its lower end, which dips a very little way into the mercury, being amalgamated, it is preserved from adhering either to the iron-wire or the glass. A very minute galvanic power being applied, by a contact with the lower and upper end of the apparatus, and the pole of a strong magnet being applied to the external end of the lower iron-wire, the moveable wire within begins rapidly to rotate round the temporary magnet thus formed; and this rotation may be inverted either by changing the contact, or by inverting the magnet. Mr Faraday states that this instrument is so sensible, that a rotation has been produced in it by two plates, each only one inch square.

Exp. II. " *To exhibit the rotation of a magnet on its axis by the effect of a galvanic wire.*

" Let ABDE, Fig. 3., represent a cup of glass or wood, NS a magnet, having at its lower extremity a fine steel point, inserted in the agate *a*; *b c* is a thin slip of brass or ivory, having a hole through which the magnet passes freely, and by means of which it is kept perpendicular: at the upper extremity N of the

magnet, is a thin cylinder, as a piece of quill, forming a cup or reservoir Z, to receive a small quantity of quicksilver; and into this is inserted the wire *z*, amalgamated at its lowest point, and C *c* is a stout wire passing through the side of the cup into the quicksilver. Then, the contact being made at C and Z, the magnet will begin to revolve on its axis, with a very astonishing velocity, and continue in motion while the power of the battery lasts.

This pleasing experiment is due to M. Ampere, who employs only a piece of platinum attached to the magnet, to produce, by its superior gravity, a vertical position of the latter in the mercury; the upper wire being then inserted into the quicksilver in the cylinder *z*, and the other wire into the cup C, the motion is produced exactly as above described: the greatest freedom of motion is, however, given by the apparatus shown in the figure. The explanation of this rotation is very obvious, according to the hypothesis we have adopted; for the tangential force of the wire acting upon the magnetic particles on the surface of the magnet, must necessarily produce the rotation in question, on precisely the same principles as the magnet is made to revolve about the wire in the fifth experiment.

Exp. III. " *To exhibit the rotation of a galvanic wire on its axis by the action of a magnet.*

" Let NS, Fig. 4., be a magnet, represented as broken in the figure, but which is fixed, in the experiment, in a foot, in order to keep it vertical, and let *a b c d* be a light hollow copper or brass cylinder, having a steel point passing downwards into the agate cup *f*, fixed to the upper end of the magnet, and let *e* be a small tube or quill fixed on the wire passing through the top of the cylinder, holding a little quicksilver, and receiving into it the descending conducting wire Z. AB is a piece of wood turned to fit on the cylindrical magnet NS, which has a hollow groove on its upper surface, to receive a quantity of quicksilver, into which the lower edge of the cylinder *a d* is slightly immersed, the surface being covered with weak dilute nitric acid. AC is a wire passing into the quicksilver. It is obvious that thus (the contact being made at Z and C) the galvanic circuit is carried from Z through the cylinder *a b c d*, thence to the quicksilver, and hence again through the wire AC to the other extre-

mity of the battery, whereby the cylinder *a b c d* is made to become a part of the conducting wire, and it will be found to revolve on its axis with a great velocity, fully equal to that of the magnet in the last experiment; the direction of the motion, with the arrangement shewn in the figure, being from left to right, to a person coinciding in position with the magnet."

Exp. IV. " *To exhibit the rotation of the galvanic wire independently of the galvanic battery.*

" For this purpose, we must employ the apparatus exhibited in Fig. 5., where ABCD is a small copper vessel about $2\frac{1}{2}$ inches high, and the same in diameter; *a b c d* is another small cylinder of copper, of the same height, soldered to the former vessel at its lower end *d c*, a hole being left in the bottom of the former to receive it. The cylinder *abcd* is therefore open, and will admit a cylindrical magnet to be passed up, and it will at the same time hold a quantity of dilute acid within the space AD *dabc*: BC Z *z* is a zinc cylinder, very light, of rather less altitude than the copper one. To the cylinders *a b* and Z *z* are soldered two copper-wires, as shewn in the figure, the upper one having a steel point proceeding from E downwards, and resting in a small metal hole at F, and consequently the cylinder Z *z* will be free to move upon its point of suspension at F.

" Things being thus prepared, and the acid placed in the cell as above described, insert through the interior cylinder the north end of a strong cylindrical magnet, and balance the whole apparatus upon it; when immediately the zinc cylinder will begin to revolve, with a greater or less velocity, according to the strength of the acid, the freedom of motion, and the power of the magnet. I have frequently, with this simple apparatus, produced a motion amounting to 120 rotations per minute. The only difference between this and the other rotations we have described is, that the galvanic power is here produced by the apparatus itself, instead of having recourse to the battery.

" For it is obvious, that the wire from Z *z* to E, may be considered as a conductor proceeding from the zinc, and the wire from *a b* to F, as one from the copper side of the battery; and, consequently, the same effect is to be expected here as in the preceding cases. It is unnecessary to add, that, with

the north end of the magnet upwards, the motion is from left to right, and the contrary with the magnet reversed. This experiment is due to M. Ampere.

" A very pleasing addition has been made to this apparatus by Mr J. Marsh. It consists in having a second point descending from F, which is made to rest in an agate cup, fixed on the top of the magnet, Fig. 6., and upon which the whole machine is balanced, having a perfect freedom of motion; and to preserve this balance, the magnet is placed vertically in a foot. The machine being now charged with acid, a compound motion takes place, the zinc cylinder revolving in one direction, and the copper vessel in another, producing thus a very pleasing effect; the latter, however, is by no means so rapid as the other, in consequence of the weight of the acid, and in fact that of the whole machine being supported on the lower point."

Exp. V. " *To show the effect of a horse-shoe magnet on a freely suspended galvanic wire.*

" Let Z *z*, Fig. 7., denote a part of the galvanic wire, freely suspended by the chain connection at *o*, proceeding from the zinc end of a battery, its lower extremity being amalgamated and slightly immersed in a reservoir of pure mercury, having a connection at C with the other extremity of the battery. NS is a horse-shoe magnet, placed as shewn in the figure.

" The contact being now made at C and Z, the hanging part of the wire *o z* will be thrown out of the mercury into the position *o z'*; the contact being thus broken, it falls by its own gravity into the mercury, by which means, the contact being renewed, it is again projected, and so on with an extraordinary rapidity; and if the position of the magnet be reversed, or the contact be changed, the direction of the motion will be changed also, but the effect will be the same.

" This singular motion may be still explained by the hypothesis that has been advanced; for the wire having a tendency to pass round the north end of the magnet to the right hand, and round the south end to the left hand, is urged by equal forces directly in a line with the open space of the magnet, the equality of the two forces preventing the rotatory motion about

either, but both conspiring to give to the wire the rectilineal motion which has been described. This experiment is also due to Mr J. Marsh.

Exp. VI.—" *To exhibit a wheel and axle rotation by means of a horse-shoe magnet.*

" The machine by which this motion is produced, is represented in Fig. 8., where AB is a rectangular piece of hard wood, CD an upright wooden pillar, DE a piece of stout brass or copper wire, and *ab* a somewhat smaller wire, soldered upon it at E, on the lower side of which the wheel W, of thin copper, turns freely; *hf* is a small reservoir for mercury sunk in the wood, and *gi* a narrow channel running into it: HH is a strong horse-shoe magnet. Mercury being now poured into the reservoir *fg*, till the tips of the wheel are slightly immersed in it, and the surface covered with weak dilute nitric acid, let the connection with the battery be made at *i* and D, and the wheel W will immediately begin to rotate with a great velocity. If the contact be changed, or if the magnet be inverted, the motion of the wheel will be reversed; but, in general, the best effect is produced when the wheel revolves inwards."

Exp. VII. " *To exhibit a compound wheel and axle rotation with two horse-shoe magnets.*

" The machine for producing this motion is shown in Fig. 9. ABGD is a rectangular piece of board, having two grooves, about half an inch deep, cut in it parallel to its length. C*p*, Z*q* are two wires having cups for connection at Z and C, and each passing into its respective groove *ab*, *cd*, filled with mercury; into which are slightly immersed the points of the wheels of W, W′; these being fixed on an axle W W′, and resting upon the two supports *mn*, *rs*, brought to a fine edge at *n* and *s*, in order to reduce the friction as much as possible, and to give the greater freedom of motion. N and S are two horse-shoe magnets, placed as in the figure, with the like poles interior and exterior of the wheels.

" The apparatus being thus prepared, and the contact made at Z and C, the wheels will begin to revolve, and in a very short

time will acquire a velocity exceeding very considerably any of the motions hitherto described.

"It is unnecessary to say, that, by changing the contact, or by inverting the magnets, the direction of the rotation will be also changed. The usual precaution of covering the surface of the mercury with weak dilute nitric acid, will increase the rapidity of rotation, but it is not actually necessary in this case."

Exp. VIII. "*To exhibit the terrestrial directive quality of a galvanic wire.*

"M. de la Rive's apparatus for this purpose consists of a small galvanic combination attached to a cork; the plate of zinc is nearly half an inch wide, and extends about one and a half or two inches below its cork, its upper end passing through the same; the slip of copper is of equal width with the zinc, but passes round it, being thus opposed to both its surfaces, as in Dr Wollaston's construction; its upper end also appears through the cork. A piece of copper-wire, covered with silk thread, is coiled five or six times, and tied together so as to form a ring about an inch in diameter, and the ends of the wire are connected, by solder, one with the zinc, and the other with the copper slip above the cork. See Fig. 10.

"When this small apparatus is placed in water, slightly acidulated with sulphuric or nitric acid, the ring becomes highly magnetic, and will arrange itself in a plane perpendicular to the magnetic meridian, or it will at least indicate a tendency to take that position, but the escape of the bubbles, arising from the decomposition of the water, prevents it from preserving a fixed direction.

"Its magnetic qualities, however, are more obviously shown by bringing to it a strong magnet. The one I made use of is cylindrical, about three quarters in diameter, and 18 inches in length. This being applied at the distance of several inches, the ring was immediately attracted, or repelled, according as one or other of the poles of the magnet was presented, or according as one or other side of the wire was opposed to the latter. When the result of the application is attraction, the cork will advance towards the extremity of the magnet, and if

the latter be held horizontally, and in a line with the centre of the former, this will continue to advance till the pole of the magnet is within the ring, and then proceed with considerable velocity till it reaches the middle of the magnet, where it remains perfectly stationary. If now the magnet be withdrawn, and changed end for end, and re-introduced into the ring, the latter will go off from the magnet.—turn itself round when quite free from it,—again advance, and settle itself as before in the centre.

"This very simple apparatus, which may be made at the expense of about a shilling, throws great light upon the nature of the electro-magnetic action, and proves most satisfactorily that, notwithstanding the intimate relation between the electro-magnetic and magnetic fluids, they are not identical; for no possible arrangement of simple magnets can be made that would lead one of them beyond the pole of another to find its state of equilibrium in the middle of the latter."

"Another form of this apparatus is shown in Fig. 11.

"Both the above apparatuses are much improved, by fixing to the cork a light glass-cylinder AB to contain the acid, instead of floating them in it; the apparatus may then be floated on common water, and all the facts exhibited as above described.

"This appendage to the original construction is due to Mr James Marsh, already mentioned."

Exp. IX. "*To exhibit the action of the terrestrial magnetism upon a galvanic wire freely suspended.*

"Let ABGD, Fig. 12. represent a rectangular piece of hard wood, having two grooves *ab*, *cd*, cut in it, parallel to its length, about half an inch in depth, which are to be filled with quicksilver for the experiment. C*p*, Z*q*, are wires fixed in the board, and passing each into its respective groove, with cups for making the connection with the battery at Z and C. O*m* is a long piece of silk proceeding from the ceiling, or some other convenient place, and to which is tied the wire *kmn*, bent as in the figure, the points *k* and *n* being slightly immersed in the quicksilver. If the connection be now made at Z and C with the zinc and copper sides of the battery, the moveable part *kmn* of the galvanic circuit, which has a great freedom of mo-

tion, will be projected towards the extremity AB of the board, and if the contact be changed, by making the zinc connection at C and the copper at Z, the wire will be driven towards the other extremity. As no magnet is introduced in this experiment, we have a right to attribute the motion to the effect of the terrestrial magnetism, the direction of it corresponding precisely with what we ought to expect from such action. For the terrestrial magnetism of our latitude being of the same kind as that exhibited by the southern pole of a magnet, the moveable wire ought to pass from right to left in the first case, and from left to right in the second, to an observer situated as forming a part of the galvanic circuit; that is to say, with the first contact the wire ought to be projected towards AB, and with the second towards DG.

" To prove that the motion proceeds from this cause, let the south pole of a strong magnet be brought under the board between Z and C, and make the contact again; and the same motion will take place, but in a much stronger degree, the wire being now thrown very forcibly out of the mercury.

" The effect therefore being precisely of the same character, but much more powerful in the latter case than in the former, we have a right to conclude that the cause of the motion in both cases is of a like nature, the one proceeding from a southern polarity artificially produced, and the other from the natural magnetic action of the terrestrial sphere, as stated by Mr Faraday, to whom we are indebted for this interesting experiment.

Exp. X. " *To produce a rotation of the galvanic wire by means of the terrestrial magnetism.*

" This is also an experiment due to Mr Faraday, and which proves, in the most satisfactory manner, the influence of the terrestrial magnetism in the production of a rotatory motion. It is performed as follows: a very light copper, or platina wire, about 6 inches long, is suspended very freely from a larger wire proceeding from either end of the battery, by means of the chain connection described in several of the preceding experiments, and at its lower extremity a small piece of cork is attached, in order to keep the wire buoyant on a basin of pure mercury, about 10 inches in diameter. The wire by which the above

small moveable piece is suspended, is then so much depressed, that the proposed revolving wire slopes at an angle of about 40° with the horizon. In this state the circuit of the battery is completed through the mercury in the basin and the other conducting wire, when immediately the short wire commences a rotation, as it would do about the south end of a magnet, but in a proportionally less degree, as the directive power of the earth is less than that of a magnet of the kind here supposed.

"This similarity of action naturally leads us to infer a similar cause, and that this cause is no other than the terrestrial magnetism; still, however, in order to render this conclusion the more indisputable, Mr Faraday changed the inclination of the wire, making it first equal to the angle of the dip; and when, under these circumstances, the wire was placed so as to coincide with the dip itself; viz. when placed in the magnetic meridian, sloping from south to north, there was no motion; and when the angle was still farther increased, so as to exceed the angle of the dip, it was projected in two different directions, according as it was made to slope to the north or to the south, which is precisely what ought to be the case, on the supposition of the motion being caused by the magnetism of the earth.

"For let *o z*, *o z'*, in (Fig. 13. and 14.), represent the freely suspended wire in the plane of the meridian, sloping respectively to the north and south: and let NS in both figures denote the direction of the terrestrial magnetism, then it is obvious in the first of these figures, that whether the slope be towards the north or towards the south, it will be always on the same side of the line NS, and will, in both cases, be projected in the same direction, with respect to the observer, situated as forming a part of the galvanic circuit, and consequently in opposite directions, as referred to the circular rotation of the extremity *z* or *z'*. But when the slope is less than the dip, then the wire, in its two positions, being found on opposite sides of the line of direction, and passing still to the same hand of an observer situated in the wire, a rotation will ensue similar to those that have been described in Experiment I.

Exp. XI. "*To exhibit the action of two galvanic wires on each other.*

"The apparatus which I employed for this purpose is shown in (Fig. 15.), where AB represents a rectangular board, and D, E, two upright pieces of wood, carrying each a cross piece at top with several holes for receiving the cups *m m'*, *n n'*, which, by this means, may be placed at different distances; a little mercury is poured into each of these, so as to communicate with the wires inserted through the side of the cup, and terminate with fine points. The wires *w a a' w'*, *w b b' w'* are bent, as shown in the figure, and have small holes drilled at *a*, *a'*, *b*, *b'*, whereby they may be hung freely upon the points of the wires *m*, *m'*, &c. and carrying small weights *w*, *w'*, &c. in order to bring the points of suspension to correspond as nearly as possible with the centre of gravity, whereby the wires are moved by the least force. The conducting wires from the extremities of the battery Z and C are terminated as represented in the figure, and being each brought to the respective cups, so that *z z'* are respectively inserted in the cups *m n*, and *c' c* into the cups *m' n'*, the circuit will be made through the two wires *a a'*, *b b'*, in the same direction; and these being free to move about the points in the respective cups, will be strongly attracted towards each other, even at the distance of several inches.

"Let now the branch *z* of the conducting wire Z *z* be lengthened, so that it may pass round the board, and be inserted in the cup *n'*, while *z'* is inserted in the cup *m* as before; lengthen also the branch *c* of the conducting wire C *c*, passing it round the board, and dipping it into the cup *n*, while *c'* is immersed in *m'* as at first; by this means, the circuit passes from *z* to *c* along the wire *b b'*, and from *z'* to *c'* along the wire *a a'*; in short, the circuits in the two wires are now made in opposite directions, and the wires experience and exhibit a mutual repulsion. Hence we learn, that two galvanic wires, parallel to each other, and in which the circuit is made in the same direction, are attracted towards each other; but they are mutually repelled when the circuit passes in opposite directions, a result first deduced by M. Ampere, and which he has made the foundation of his theory of electro-magnetism, by assuming, that the powers exhibited by

artificial and natural magnets are due to currents of the galvanic fluids circulating in planes perpendicular to their axis; and, that those currents, when parallel to each other, and passing in the same direction, are attracted, and when in opposite directions, repelled.

" Whether this hypothesis and that which I have advanced be under different forms only one and the same, and if not, which may be considered as the most conclusive and satisfactory, are not for me to determine: they are now both in the hands of philosophers, who will judge of them impartially, and adopt that which seems to answer best to the various facts and phenomena that have been, and that may still be, elicited by the ingenious experimenters at present engaged in this interesting inquiry: I must say that I cannot, on M. Ampere's doctrine, satisfactorily explain several of the phenomena exhibited in the preceding experiments; and the following is another case which seems to be at variance with the theory in question; viz.—

" Let only one of the bent wires, shewn in the figure last referred to, be employed, and let it be made a part of the galvanic circuit. If now a long magnet be placed horizontally, with one pole a little below the horizontal part of the wire, and perpendicular to the same, the wire will be strongly attracted, or repelled, according to the pole that is presented. Let us suppose that the wire is attracted; this may be explained by the assumed attraction of the current in the wire, and the parallel currents in the same direction in the magnet, agreeably to M. Ampere's theory; and if it be repelled, the explanation will still subsist by supposing the parallel currents in opposite directions; but if, now, instead of keeping the magnet perpendicular to the direction of the wire, we place it parallel to it, keeping the same extremity still under the wire, the very same effect is produced; although, in this case, the supposed magnetic currents, *if before parallel* to that in the wire, are now necessarily *perpendicular to it*: and if, again, the magnet be held vertically, keeping the extremity presented to the wire in its situation, or as nearly so as possible, the same attraction still takes place; and this, whether the extremity in question be above or below; in short, while the pole of the magnet presented to the wire is kept in its position, whatever direction be given to the magnet itself, whether in azi-

muth or inclination, the same motion takes place, which certainly appears to me to be wholly at variance with the doctrine that M. Ampere has endeavoured to establish. And if, instead of using the magnet, we leave the wire to the action of the terrestrial magnetism only, a similar effect, but in a less degree, is produced every time the connection with the battery is established: and it is the same whether the wire be placed at N and S, E and W, or at any azimuth whatever; a fact which seems to be equally at variance with M. Ampere's theory of terrestrial magnetism.

"Whether this ingenious author, for whose talents I entertain the highest respect, will be able to reconcile these phenomena with his theory, I am unable to say; but if he can, no one will be more ready than myself to admit his doctrine, being fully aware of the great advantages which philosophy derives from the reduction of a variety of classes of phenomena to one general principle: at the same time we must [illegible] not to generalize too quickly; nor, in our anxiety to avoid the introduction of a force, hitherto unknown in nature, allow ourselves to leave imperfectly explained some of the most interesting facts yet elicited by experimental philosophy."

ART. XVII.—*Description of the Lamps with Concentric Wicks, and with a superabundant supply of Oil, as adopted in the French Light-houses* *.

THE advantages of several concentric wicks in lamps, has been long ago pointed out by Count Rumford; and M. Carcel, in his ingenious mechanical lamp, had employed the happy idea of keeping the wick constantly wet with a quantity of oil greater than it could consume. In applying the contrivance of Carcel to the double, triple, or quadruple wicks of Count Rumford, MM. Arago and Fresnel, instead of raising the oil by a piece of clock-work as Carcel did, employed a reservoir higher than the wick,

* This notice is abstracted from M. Fresnel's *Mémoire sur un Nouveau Système d'Eclairage des Phares*, Paris 1822, already quoted in this volume, p. 165.

which receives the oil by a tube sliding in a leather box, which may be raised or depressed at pleasure, and which serves to regulate the level of the discharge of the oil. The superabundant oil falls into a reservoir placed below the wick, which is emptied into the reservoir when the lamp is extinguished.

It is of the greatest consequence in all these lamps, to regulate the current of air. When the chimney is too low, the wick becomes hot, and the flame lengthens and reddens; and when the chimney is too high, the current of air becomes too rapid, the flame grows white, but is very small, and experiences a constant agitation by the too great velocity of the air.

In order to regulate the velocity of the air, the authors above mentioned have used the construction in Fig. 21. Plate VII., where F is a second tube, moveable up and down in E, by means of the screw nut D, working in a rack GG, till the flame has the proper colour and size. This contrivance, however, was found not to answer well in practice, and they afterwards substituted in place of it a sort of valve made of iron or platinum, placed at the bottom of the chimney, and made to turn upon an axis, so as to admit more or less air. In this case, the chimney must be made larger than is necessary, and the current has its velocity diminished by means of the valve.

The construction of the burners will be understood from Plate VII. Fig. 18., which is the plan of one with *four wicks*, and which is nearly equivalent in its light to twenty of Carcel's lamps. The intervals which separate the wicks, and allow the currents of air to pass, diminish a little in width from the central to the external wick. The section of this burner is represented in Fig. 19., where C, C′, C″, C‴, (See also Fig. 18.) are the racks by means of which each wick may be raised or depressed. AB is the horizontal projection of the tube, which conducts the oil to the wicks. L, L, L, L, are small plates of white iron, to which the beaks are soldered. N is a pressure screw for keeping at a proper height the piece RRR, which supports the chimney.

Fig. 21. shows the elevation of the burner with four wicks, supporting the chimney.

Fig. 20. shews the way in which the moveable ring which carries the wick is placed upon the fixed ring soldered to the rack.

Art. XVIII.—*Celestial Phenomena, from April* 1. *to July* 1. 1823, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.

April.

D	H	′	″	
3.	12	35	30	☌ ☽ ♅
	15	0	47	☾ Last Quarter.
4.	20	35	17	Em. II. sat. ♃
9.	19	24	18	☌ ☽ ☿
10.	23	57	49	☌ ☽ ♂
11.	6	36	22	● New Moon.
12.	16	20	14	☌ ☽ ♄
	20	42	21	Em. I. sat. ♃
13.	6	26	26	☌ ☽ ♉
	20	32	40	☌ ☽ *η* ♉
14.	10	59	57	☌ ☽ ♃
18.	0	36	3	☽ First Quarter.
20.	22	5	12	☉ enters ♉
25.	6	44	29	○ Full Moon.
27.	22	46	5	☌ ☽ *α* ♏
29.	20	9	9	Em. III. sat. ♃
30.	20	17	11	☌ ☽ ♅

May.

D	H	′	″	
3.	9	32	7	☾ Last Quarter.
6.	20	14	20	Em. II. sat. ♃
9.	22	16	30	☌ ☽ ♂
10.	7	41	16	☌ ☽ ♄
	15	37	1	● New Moon.
11.	16	6	50	☌ ☽ ☿
12.	5	27	4	☌ ☽ ♃
13.	1	49	10	☌ ☽ ♀
17.	7	15	11	☽ First Quarter
21.	22	22	37	☉ enters ♊
24.	20	50	28	○ Full Moon.
25.	5	44	5	☌ ☽ *α* ♏
28.	1	23	39	☌ ☽ ♅
28				☿ greatest elong.

June.

D	H	′	″	
2.	1	6	16	☾ Last Quarter
6.	23	44	41	☌ ☽ ♄
7.	18	56	30	☌ ☽ ♂
8.	23	33	58	● New Moon.
9.	1	17	18	☌ ☽ ♃
10.	6	43	27	☌ ☽ ☿
11.	19	12	55	☌ ☽ ♀
15.	15	10	1	☽ First Quarter.
22.	6	58	16	☉ enters ♋
23.	11	52	3	○ Full Moon.
24.	5	39	10	☌ ☽ ♅

From the effect of the Moon's parallax in Longitude, the apparent conjunction of the Moon with *η Tauri* on the 13th of April, will take place after the true; but want of leisure has prevented me from making a particular calculation. The occultation, however, will be visible. There may also be occultations of *Atlas*, *Pleione*, *Electra*, &c.

For the reason above mentioned, I am not certain whether the occultations of *Antares* by the Moon will be visible at Edinburgh, but it is more probable that they will be seen at Greenwich.

N. B. In last Number, p. [illegible]. *for* Eclipse begins *January*, read *July*.

Art. XIX.—*Proceedings of the Royal Society of Edinburgh.* (Continued from p. 180.)

Dec. 16. 1822.—A paper by Dr Macdonald was read, "*On the Theory of the Formation of Calcedony.*"

On the same evening a notice by Dr Brewster was read, "*On Mr Barton's Method of Ornamenting Steel and other Metals.*"

Jan. 13. 1823.—Mr P. F. Tytler read a continuation of his "*Biographical Sketches of some of the earliest of our Scottish Lawyers.*"

On the same evening, Captain Scoresby exhibited to the Society his Magnetimeter and Chronometrical Compass, and performed a series of new Magnetical Experiments.

Jan. 20.—A paper by Dr John Hunter, Professor of Humanity, St Andrew's, was read, entitled, "*Observations on certain analogies observed in the formation of the Tenses of the Greek Verb.*"

Feb. 3.—Mr Thomas Allan read a paper, entitled, "*Observations on the Formation of Calcedony.*"

At the same meeting a paper by Dr Brewster was read, "*On a New Property of Reflected Light.*"

The following Members were elected at this meeting.

HONORARY MEMBER.

M. Goethe.

FOREIGN MEMBERS.

M. Decandolle, Geneva.
Dr Olbers, Bremen.
The Bishop of Zealand.
M. Oriani, Milan.
M. Dupin, Paris.
M. Brongniart, Paris.
The Chevalier Burg, Vienna.
M. Breislak, Milan.
M. Bessel of Konigsberg.

ORDINARY MEMBERS.

Right Hon. Sir G. Warrender, Bart.
John Russell, Esq.
John Shaw Stewart, Esq.
Dr Alexander Hamilton.
Dr Thomas Harland.
John Dewar, Esq.
Right Hon. Sir William Rae, Bart.
Sir Robert Dundas, Bart.
William Cadell, Esq.
Sir William Knighton, Bart.
Sir E. F. Bromhead, Bart. A. M., F. R. S.

At this meeting Dr Hope and Professor Russell were chosen Resident Vice-Presidents.

Feb. 17.—A paper by the Reverend Dr Lee was read, entitled, '*Observations on the Life and Character of Sir George*

Mackenzie of Rosehaugh, with remarks on his History of Scotland."

On the same evening a notice was read by Dr Macdonald, "*respecting the formation of solid Chalcedonic Nodules in Trap Rocks.*"

Mar. 3.—Dr Hibbert read a paper "*On the Physical Causes which have given rise to the popular belief in Apparitions.*"

At the same meeting a paper by Dr Brewster was read, "*On the existence of a New Fluid, possessing remarkable Physical Properties, in the cavities of certain Minerals.*" A notice of this paper will be found in our Scientific Intelligence, p. 400.

At this meeting the following gentlemen were elected Members:

Sir James Stuart, Bart. of Allanbank.
Sir Andrew Halliday, Knight, Physician to His R. H. the Duke of Clarence.
John Bonar, Esq.
Alexander Waddell, Esq.

ART. XX.—*Proceedings of the Wernerian Natural History Society.*—(Continued from p. 182.)

Dec. 14. 1822.—AT this meeting, a paper by the Reverend Dr Fleming of Flisk was read, containing "*Observations on subjects connected with Natural History, made in a Voyage round the North of Scotland, in the autumn of* 1821" (The first part of this paper is printed in the present number of this Journal, p. 294. *et seq.*) There was likewise read, an "*Account of a Marine deposit, observable among the floetz strata on the margin of Loch Lomond,*" by Mr James Adamson. And Professor Jameson gave an account of a fine specimen (which was exhibited to the meeting) of the *Zeus Luna* or *King Fish*, lately taken in the Frith of Forth.

Dec. 28.—The Secretary read the first part of the "*Journal of a Visit to the Summit of Adam's Peak, the highest mountain of Ceylon,*" by Mr Henry Marshall, staff-surgeon. Mr Greville then read an "*Account of the Esculent Fungi of Great Britain.*" Dr Knox read a "*Notice relative to the Habits of the Hyænas of Southern Africa*," shewing that they are not in the practice of conveying their prey into their dens: and Dr Yule communi-

cated *Specimens of Maize*, ripened in Scotland, in the garden of North Dalrymple, Esq. and made some observations on the practicability of naturalizing that grain.

At this meeting, the following presents were laid on the table: "*Abstracts of the Population Returns*," in a large volume folio, presented to the Society by order of Government; and the *American System of Mineralogy*, &c. by Mr Parker Cleaveland, two vols. 8vo.

Jan. 11. 1823.—The Secretary read the second and concluding part of an "*Account of a Journey to Adam's Peak in Ceylon*," by Mr Marshall, staff-surgeon. Likewise an "*Extract of a Letter from the Reverend William Dunbar of Applegarth, to Principal Baird*," detailing experiments and observations which confirm the doctrines of Schirach and Huber, respecting the conversion of common larvæ into queen-bees, in particular circumstances. The Secretary also read a "*Proposal for an Improvement in the form of Cannon-balls, calculated to communicate the advantages of projecting them from a Rifled Barrel*," by Mathew Miller, Esq. of the 51st regiment.

Dr Hibbert then read an "*Additional Account of the Expedients resorted to by a Boy in Cheshire, to supply the deficiency of Fore-arms and Hands*," and presented a portrait of the boy.

Mr Innes of Stow exhibited to the meeting some admirable specimens, dated "Edinburgh, 1723," of *Drawings and ornamental Penmanship*, by Matthew Buckinger, a person who was destitute of hands and feet.

Jan. 25.—The Secretary read a notice by Mr James Adamson, regarding the principles on which the motion is communicated to steam-vessels. Also, a paper on the identity, considered as species, of the Golden and the Ringtailed Eagles, by Mr P. J. Selby of Twizel-House.

Professor Jameson read an "*Account of a remarkable Thunder Storm in Berwickshire*," in the course of which, all surrounding objects assumed the colour of copper. He then exhibited *the Horn of a Rhinoceros*, found in digging marl at the Loch of Forfar, and stated reasons for believing it to have belonged to a species of rhinoceros which had formerly inhabited this island. He next laid before the meeting, the *skeleton*, and also the *stuffed skin*, *of the Dugong of Singapour*, an animal allied to the porpesse,

and which, when it raises its head and upper extremities, containing protuberant mammæ, above the water, may probably have given rise to the fable of the Indian mermaid. He likewise read remarks by Dr Traill of Liverpool, on *American Animals of the genus Felis.*

ART. XXI.—*Proceedings of the Cambridge Philosophical Society for* 1822. (Continued from Vol. VI. p. 378.)

Feb. 25.—" SOME *observations on the Weather, accompanied by an extraordinary depression of the Barometer, during the month of December* 1821," by the Rev J. Hailstone, M. A. late Woodwardian Professor.

Mr Henslow concluded his paper on the Geology of Anglesea.

March 11.—The meeting was adjourned in consequence of the death of the Vice-President, the Rev. Dr Clarke, Professor of Mineralogy.

March 25.—" *Description of a new Self-regulating Lamp,*" by the Rev. W. Mandell, B. D., Fellow of Queen's College.

The peculiar advantages of this lamp are, 1*st*, The surface of the oil in the burner is constantly at the same distance from the flame; 2*d*, *That it consumes all the oil.*

H. B. Lesson, Esq. read a description of a safety apparatus attached to the Hydrostatic Blowpipe of Tofts, by which it may be converted into an oxy-hydrogen blowpipe, without danger to the operator.

A paper was communicated to the Society by G. B. Airy, Esq. of Trinity College, the object of which was, to investigate, on the Newtonian Theory of Refraction, the alteration which would take place in the focal length of an object-glass, from an alteration in the velocity of light, whether arising from the motion of the earth, or from a motion in the stars or bodies observed. It was then proposed, after verifying the theory by observations of the same star at opposite seasons of the year, to determine the proper motions of the stars in the direction of lines drawn to the earth, by observing the focal length

of the telescope. It was shewn that the change would be such as might, under favourable circumstances, be capable of being estimated by observation; and the precautions were mentioned which would be necessary for its accurate determination.

April 22.—A paper was read "*On the Distribution of the Colouring Matter, and on certain peculiarities in the structure of the Brazilian Topaz*;" by David Brewster, LL.D. F.R.S. &c.—This paper was divided into the following heads:

1. On the distribution of the Colouring Matter in Topaz.

2. On the Tesselated Structure of the Brazilian Topaz, and the singular superposition of its External Laminæ.

3. On the Optical Structure and Properties of Brazilian Topaz.

4. On substances found in the Brazilian Topaz.

5. On the probable difference in the Chemical Composition of the Brazilian and other Topazes.

Under the last head, the author observes that the late Rev. William Gregor detected Lime and Potash in the Brazilian Topaz which sufficiently accounts for the difference between its Optica Structure, and that of the other Topazes.

May 6.—"*On the Rotation of Bodies*;" by W. Whewell, M. A. Fellow of Trinity College.—Mr Whewell began by giving a short history of the problem of the motion of a body of any figure, about its centre of gravity. D'Alembert first solved this problem in 1749; and Euler, in 1758, put the formula in what is now the usual form. Mr Landen gave a different solution in the *Philosophical Transactions* for 1785, and to the end of his life maintained the results of the continental mathematicians to be erroneous. Mr W.'s object was to put the error of Mr Landen in the clearest point of view, by reducing the question to the formulæ for the motion of points. If a triangular pyramid, without inertia, having material points at three of its angles, revolve anyhow about its remaining angle or vertex, it may be considered as a solid body; and, by investigating this case, the truth of Euler's formula is fully established. It appears also, that if the angles at the vertex of the pyramid be right angles, its motion may be made to coincide with that of any given solid body, by properly adjusting the magnitudes of the three material points.

May 21.—"*On the Basaltic Dikes in the County of Durham, and on the Great Basaltic Formations in Teesdale*;" by the Rev. Professor Sedgwick, M. A. Fellow of Trinity College.

May 22.—Being the Anniversary Meeting of the Society, the following officers were elected for the ensuing year:

President,—The Very Rev. Dr Wood, Master of St John's, and Dean of Ely.
Vice-President,—Rev. T. Turton, B. D., Lucasian Professor of Mathematics.
Treasurer,—Rev. B. Bridge, B. D., Fellow of Peterhouse.
Secretaries, { Rev. G. Peacock, M. A., Tutor of Trinity.
J. S. Henslow, M. A., Professor of Mineralogy.
Steward of the Reading-Room,—W. Whewell, M. A. Fellow of Trinity.

Members of the Council, {
Rev. J. Cumming, M. A., Professor of Chemistry.
Rev. S. Lee, M. A., Professor of Arabic.
Rev. T. S. Hughes, B. D., Fellow of Emmanuel.
Rev. T. Chevallier, M. A., Tutor of Cath-Hall.
Rev. A. J. Carringham, B. D., Fellow of St John's.
Rev. A. Dickson, M. A., Fellow of Peterhouse.
J. King, M. A., Tutor of Queen's.

A paper was read by W. Whewell, M. A. Fellow of Trinity College, on two mechanical problems. The first was the oscillation of a chain or string, suspended vertically, and slightly displaced. There are an infinite number of cases in which the chain can oscillate symmetrically, which are given by the roots of an equation of an infinite number of terms. Euler had found one of the roots of this equation. Mr W., by a particular mode of approximation, has found values for all of them, and determined all the positions of the chain which give symmetrical oscillations. The other problem was that of the motion of a body oscillating, while it is drawn up uniformly; which has been attempted by some English mathematicians, and which is found, when solved approximately, to have some relations with the former problem of this paper.

A communication of some Electro-Magnetic Experiments, by Gybbon Spilsbury, Esq. In repeating the experiments of Professor Cumming, on the different electric relations of iron and steel, copper and brass, &c., Mr Spilsbury found, that the galvanoscope was sensibly affected, not only when a metallic rod was placed in galvanic contact, with any alloy of the same metal, but when similar metallic alloys were presented to each other, provided they were of different dimensions. If two rods of steel, one being larger than the other, were immersed in an acid, on completing the galvanic circuit, the effect on the

galvanoscope, was the same as if the larger had been composed of a more oxidizable metal. The effect of two brass-rods was the same, under the same circumstances. A similar effect was produced by equal rods, provided that one of them, by being placed obliquely in the acid, presented a greater surface to its action. Mr Spilsbury then noticed the effects produced by interposing water, or different acids in the galvanic circuit. The paper was concluded with a theory, by which Mr Spilsbury proposed to account for these effects, and a description of a mode of increasing the sensibility of the galvanoscope, by suspending the needle from a fine silk fibre, and inclosing the instrument in a glass case.

Nov. 25.—" *On the Construction of Achromatic Reflecting Telescopes, with silvered Lenses in the place of Metallic Mirrors,*" by G. B. Airy, Esq. Trinity. The advantages of this construction were described, and it was shewn, by an investigation of the requisite formulæ, that the aberrations, both spherical and chromatic, of the two mirrors in Gregory's or Cassegrain's telescopes, might be made to correct each other; rules were given for the determination of the radii of the surfaces, and a formula investigated for making the eye-piece achromatic. It was mentioned, that an experiment had been tried, which had not entirely succeeded, though the principle appeared to hold good, and that the trial, on the whole, gave hopes of more complete success.

Dec. 9.—A paper was read, by the Rev. G. Peacock, M. A., Tutor of Trinity, " *On the Principles commonly employed in the Demonstration of the Binomial Theorem.*" After defining the meaning of the term Equal or Equivalent, as applied to two algebraical expressions, Mr Peacock proceeded to consider to what extent most writers on this theorem have assumed the existence of a general form of the series, and whether such an assumption can be considered as perfectly legitimate, consistently with other assumptions in algebra. This paper concluded with some remarks on the steps of the process which appear to have led Newton to the discovery of this theorem, as described by himself in the second of his celebrated letters to Oldenburg.

A paper was read by the Reverend W. Cecil, M. A., Fellow of Magdalene, describing a machine for grinding and polishing spherical telescopic mirrors, very accurately, and without manual labour.

The mirror is made to pass across the convex leaden tool, by a rectilineal motion, while the mirror and the tool revolve, very slowly, with any required velocity, about their common axis, in opposite directions. The angular velocity of the mirror is for certain reasons twice the angular velocity of the leaden tool. Towards the end of the process an approximation may be made to a paraboloid, or to any conic section, by making the rotatory motion rapid, and the rectilineal motion short and slow, over a convex spherical surface, deficient by sectors, varying according to a certain law.

Art. XXII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *New Elements of the second Comet of* 1822.—This comet, whose elliptical and parabolic elements we gave in our last Number, was seen in October, and observed by Professor Shumacher and Dr Olbers. The following elements, calculated by Mr Hansen, represent the observation of these astronomers:

Time of Perihelion, 1822. Oct. 23. 57745, at Altona *, near Hamburgh.

Long. of Perihelion, - - - -	271° 53′ 32″ .1
Long. of Asc. Node, from the Mean Equinox of 1st September,	92 38 17 .9
Inclination of Orbit, - - - -	52 36 51 .7
Log. of shortest distance, - - - -	0.0597898
Motion, - - - - - -	Retrograde.

These elements, compared with the observations of Professor Schumacher and Dr Olbers, do not indicate an elliptical orbit.

2. *Bessel's Survey of the Heavens.*—That excellent and assiduous astronomer, M. Bessel of Konigsberg, is engaged in an important work, containing a Survey of the Heavens in zones. The first part of the work will speedily appear

OPTICS.

3. *On the Double Refraction of Compressed Glass, and of Glass that is rapidly cooled.*—Dr Brewster had long ago concluded, (*See Philosophical Transactions* 1816, p. 46, and *Id.* 156,

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* This place is 30m 39s East of Paris.

but particularly 1818, p. 259,–267; –*Edinburgh Transactions* vol. viii. p. 353, and this *Journal*, vol. vii. p. 178), from the perfect similarity between the phenomena of heated and of compressed glass, and those of natural crystals, not only in producing the same polarised tints, but in exhibiting the phenomena of moveable polarisation, that the glass possessed double refraction, and that the cause of its not being seen was the small angular separation of the images. This conclusion he considered as demonstrated, when he found not only that the doubly refracting force in regular crystals varied in intensity, and in character, *precisely* as the polarising force varied; but that he could communicate to glass the form and structure which produced single positive axes, or single negative axes of polarisation, or double rectangular axes of polarisation; and, especially, when he had proved that the polarised tints in glass could be actually computed *a priori*, by the very same mathematical formulæ, *mutatis mutandis*, by which all the phenomena of polarisation in regular crystals, with one and two axes, had been brought under the dominion of calculation.

This opinion, though supported by such invincible proofs, and even rendered necessary by Dr Young's beautiful law of interference, was not only opposed, but ridiculed by some French philosophers. It has now, however, been established by direct observation. M. Fresnel, of the Academy of Sciences, whose labours we have so often spoken of with the highest praise, has distinctly rendered visible the two doubly refracted and oppositely polarised rays in glass when compressed, and Dr Brewster has done the same in glass that has received the doubly refracting structure from rapid cooling. M. Fresnel's experiments are described in the *Bulletin de la Société Mathematique* for September 1822, p. 139.

4. *Mr Ramage's new Reflecting Telescope of a large Size.* Mr Ramage of Aberdeen has finished the speculum of a new reflecting telescope, FIFTY-THREE FEET in focal length. The diameter of the large speculum is twenty inches.

5. *Prize offered for the best Theory of Haloes, &c.*—The Royal Academy of Sciences of Prussia have offered their prize of fifty ducats, for the memoir which gives "A complete mathe-

matical theory of the luminous or coloured circles which form around the Sun or Moon, and such a one as shall equally agree with the results of observations, and with the known properties of light in the atmosphere." The possible influence of the inflexion and the polarisation of light is to be considered. The memoirs to be sent in before the end of March 1824.

6. *Method of forming Three Haloes artificially round the Sun, or any luminous object.*—The following experiment, which illustrates in a pleasing manner the actual formation of haloes, has been given by Dr Brewster:—Take a saturated solution of alum, and having spread a few drops of it over a plate of glass, it will rapidly crystallise in small flat octohedrons, scarcely visible to the eye. When this plate is held between the observer and the sun, or a candle, with the eye very close to the smooth side of the glass-plate, there will be seen three beautiful haloes of light, at different distances from the luminous body. The *innermost halo*, which is the whitest, is formed by the images refracted by a pair of faces of the octohedral crystals, not much inclined to each other. The *second halo*, which is more coloured, with the blue rays outwards, is formed by a pair of faces more inclined; and the *third halo*, which is very large and highly coloured, is formed by a still more inclined pair of faces.

Each separate crystal forms three images of the luminous body, placed at points 120° distant from each other, in all the three haloes; and as the numerous small crystals have their refracting faces turned in every possible direction, the whole circumference of the haloes will be completely filled up.

The same effects may be obtained with other crystals, and when they have the property of double refraction, each halo will be either doubled, when the double refraction is considerable, or rendered broader, and otherwise modified in point of colour, when the double refraction is small. The effects may be curiously varied, by crystallising, upon the same plate of glass, crystals of a decided colour, by which means we should have white and coloured haloes succeeding each other.

7. *Theory of Haloes.*—The first rational explanation of haloes was given by Mariotte, and was improved and extended by Dr Young. [illegible] Mariotte and Dr Young state it as a hypothesis,

that *equilateral prisms* of ice, with angles of 60°, float in the air with their angles in all possible directions, and thus produce the halo. More numerous and recent observations have established the truth of this hypothesis beyond a doubt. Dr Brewster has shewn, that the crystals of ice always belong to the rhomboidal series of Mohs, including the six-sided prism of Haüy, whose angles are 60°; and Sir Charles Giesecké, in the article *Greenland*, in the Edinburgh Encyclopædia, vol. x., p. 387, and other travellers, have put it beyond a doubt, that particles of ice float in the air, and actually prick and blister the skin, with the same sensation that would be produced by needles, during the prevalence of what is called the *Frost Smoke*. The singular compound figures, which are almost always hexagonal combinations, drawn by Captain Scoresby, in his interesting *Account of the Arctic Regions*, shew what a variety of forms are likely to be produced in the circles which surround the sun and moon, by the combination of elementary prisms of ice.

8. *Parhelia.*—Two beautiful parhelia or mock suns were observed from York, for the space of three quarters of an hour, between two and three o'clock in the afternoon of Saturday the 8th March, at the distance of 24 degrees from the sun, and in a line parallel with the horizon. The brilliancy, which for one or two short periods became distressing to the eye, was occasionally impaired by the intervention of some light fleecy clouds moving slowly and at a considerable altitude, but was not affected whenever the same clouds passed over, and sometimes nearly obscured, the face of the sun. The sky, in other directions clear and serene, was slightly tinged by a whitish vapour floating apparently at a great elevation above the surface of the earth at the place of their appearance,—the sun itself being partially obscured by the same vapour. The sides of the parhelia nearest the sun were of a red tint, shaded into orange and yellow, and for a short interval two segments of a whitish halo passing through the parhelia were perceptible. Altitude of the sun and parhelia, at the time of their greatest brilliancy, $22\frac{1}{2}$°: Barometer 29.736: Thermometer in shade 41°. Wind brisk from NNW. This meteor, of very unfrequent occurrence in England, appears to have been similar in many respects to one described in Parry's Voyage, p. 156.

METEOROLOGY.

9. *Remarkable Cold in Inverness-shire on the 5th and 6th of February.*—A very extraordinary degree of cold was observed on Wednesday the 5th of February 1823, at the Doune, the seat of J. P. Grant, Esq. M. P. of Rothiemurchus.

The following are the observations which were made with Fahrenheit's thermometer:

1823.				
Feb. 5.	7 o'clock	P. M.	+ 2°	or above zero.
	8	P. M.	— 2½	or below zero.
	9½	P. M.	— 8°	or below zero.
Feb. 6.	11	P. M.	— 10	or below zero.
	1½	A. M.	— 15	or below zero.
	7	A. M.	— 9	or below zero
	9	A. M.	— 2	or below zero
	10½	A. M.	+ 20	or above zero.

This sudden rise of the thermometer was succeeded by a shower of snow. The thermometer stood at + 20° all the day and evening. This depression of the thermometer is the most remarkable that has ever been recorded in Scotland, being a degree lower than the great cold of January 14. 1780, when Dr Wilson of Glasgow observed the thermometer at — 14° below zero. On Wednesday, February 5., the thermometer was lower in Edinburgh than at any other time this season. On the evening of that day we observed it at + 23°, and in a very short time we saw it sink to + 12½°.

10. *Temperature of Springs and Deep Wells.*—The Royal Society of Edinburgh has received various interesting observations on the temperature of springs and deep wells, from different parts of Scotland. These observations are of very great interest, and ought to be made in every part of the kingdom. Those who are not able to keep a regular register of the thermometer, might, without any difficulty, take the temperature of a spring *twice or thrice* every month of the year, which would give results of great value.

11. *Mean Temperature of Cape Town.*—Mr Colebrook, in a paper on the Climate of South Africa, published in the Journal of Science, No. 28. p. 241., has stated the mean temperature of Cape Town at 67°.33 Fahrenheit, and the extreme

at 96° and 45°, as deduced from several years observations. Mr Colebrook has given the following additional results:

	Mean. Temp.	Extremes.
Stellenbosch,	66°.33	87° and 50
Zwartland, -	66 . 5	85 and 54
Tulbugh, -	66 .66	95 and 52

The observed mean temperature of Cape Town agrees in a very remarkable manner with Dr Brewster's Formula of Mean Temperature $= 81\frac{1}{2}$ cos lat.; for in the present case we have

$81\frac{1}{2}$ cos 33° 55′ 15″, - - - - -	$= 67°.6$
Observed mean temperature, - - -	67 .3
Difference	0°.3

12. *Variation in the Bulbs of Thermometers.*—In mercurial thermometers with a perfect vacuum above the mercury, M. Flauguergues has observed, that the freezing point has gradually risen *nine-tenths* of a degree, and has gone on increasing for years. He attributes this to a permanent change of form, produced by the constant pressure of the atmosphere on the bulb. He therefore recommends, that thermometers should be made with open terminations. The same fact had been long before observed by M. Angelo Bellani of Milan, who mentions a very pretty experiment, for shewing that it arises from the glass. Take a mercurial thermometer, which has not been exposed for some months to temperatures near that of boiling water, whose scale rises to the boiling point or higher, and whose degrees are at least a line long, so that *tenths* of a degree can be easily seen. Having carefully marked the freezing point, plunge it in boiling water, and, upon replacing it in melting ice, it will be found, that the freezing point has sunk $\frac{1}{10}$th of a degree, in consequence of the expanded glass not having resumed accurately its original form. Hence, it follows, that the new barometer of the Rev. Mr Wollaston, must be liable to error from this cause.—See *Bibl. Univers.*, vol. xx. p. 117., and vol. xxi. p. 252.

13. *On the cause of the Ascent of Clouds in the Atmosphere.*—M. Fresnel has ascribed the ascent of clouds in the atmosphere principally to the following cause. Air and all colourless gases allow the solar rays, and even radiant heat, to pass through them, without heating them sensibly. When a cloud, therefore, is composed of small globules of water, or minute crystals of snow, the

air in the interior of the cloud becomes heated, by its numerous contacts with those globules which are susceptible of being heated. Hence the air will dilate, and the cloud will rise in the atmosphere, to a height depending on the fineness of the particles of the cloud, and on the intervals which separate them. —See the *Bull. de la Soc. Math.* in Oct. 1822, p. 159.

14. *On the Cause of the Suspension of Clouds.*—M. Gay Lussac, in the *Ann. de Chim.*, vol. xxi. p. 59., ascribes the suspension of clouds to ascending currents, which push them upwards, until this force of impulsion is balanced by the weight of the cloud. A soap bubble, he remarks, will not rise in a room, but will descend directly when left to its own weight; but if the bubble is blown in the open air above a heated soil, it will rise to a height more or less considerably. It remains, however, to be determined, how much of this effect is owing to the cause assigned by M. Fresnel, and how much to the mere mechanical force of the current of heated air. It is quite obvious, that both causes must operate to a certain extent.

15. *Meteoric Stone in the department of the Vosges.*—On the 13th September 1822, a meteoric stone fell in the commune of la Buffe, during a thunder storm, accompanied with intense lightning. At 7 A. M., a noise was heard like that of a carriage descending over a rough road; it lasted seven minutes, and became at last terrific. The meteor then exploded on the ground, and fragments of a meteoric stone were found in a round hole.—*Ann. de Chim.*, vol. xxi. p. 17.

HYDRODYNAMICS.

16. *Perkins' New Steam-Engine of great Power.*—In our last Number, p. 186., we inserted a short notice of this great invention, which we copied from a letter written by the inventor's own hand to a scientific friend in Edinburgh. We have seen various letters from individuals of great scientific zeal and intelligence, who have had repeated communications with Mr Perkins himself, and we cannot doubt that Mr Perkins' invention will turn out one of great value, even if it shall not realise all the expectations which have been entertained from it. One of Mr Perkins' engines is probably by this time in actual operation. " This engine," says the editor of the London Journal of Arts,

" is intended to exert a power equal to *ten* horses: its *generator* (in place of a boiler) holds about *eight* gallons. The working cylinder is only eighteen inches long. The parts have been proved by hydraulic pressure to bear a force equal to *two thousand* pounds on the square inch; but a weak part has been subsequently introduced into it, which shall give way at *one thousand* pounds of pressure, the engine being intended to be worked by steam raised to *seven hundred* pounds."

17. *Steam Ships building by Government.*—Two steam-vessels have just been fitted out in Deptford dock-yard, one of 225, and another of 180 tons burthen. Other two are building, each of 296 tons, and 126 feet long, to be impelled by engines of 100 horse-power.—*London Journ. of Arts,* vol. v. p. 151.

18. *Quantity of Water in the Rhine at Basle.*—M. Escher has found, that the mean quantity of water which flows down the Rhine at Basle, in one year, is 1,046,763,676 cubic toises, of 1000 cubic feet each.

ELECTRO-MAGNETISM.

19. *Dr Seebeck's Electro-Magnetic Experiment.*—Dr Seebeck of Berlin took a bar of antimony about eight inches long, and half an inch thick, and connected its extremities, by twisting a piece of brass-wire round them, so as to form a loop, each extremity of the bar having several coils of the wire. By heating one of the extremities for a short time at a spirit-lamp, electro-magnetic phenomena were exhibited in every part of it. " The brass-wire," says the editor of the Quarterly Journal, who has repeated the experiment, " is in that state which would be produced, by connecting its heated end with the negative pole of a voltaic battery, and its cold end with the positive pole."

20. *M. Erman's Electro-Magnetic Apparatus.*—Having placed a watch-glass in a silver or copper crucible, and a small mass of zinc in the glass, he fastens a strip of zinc or of tin at one end to the mass of zinc, and, extending upwards and outwards over a pasteboard band, in which the cup rests, it is fastened at the other end to the cup itself. A complete voltaic circuit being thus formed, the circuit is established, by filling the cup with acidulated water. If this apparatus is suspended by a thread, and a magnetic bar brought near it, either an at-

traction or a repulsion takes place, according to the direction of the galvanic current in the apparatus, and the magnetic current in the bar.—*Bibl. Universelle.*

II. CHEMISTRY.

21. *A New Fluid, with remarkable Physical Properties, discovered in the Cavities of Minerals.*—A new fluid, of a very singular nature, has been recently discovered by Dr Brewster, in the Cavities of Minerals. It possesses the remarkable property of expanding about *thirty* times more than water; and, by the heat of the hand, or between 75° and 83°, it always expands so as to fill the cavity which contains it. The vacuity which is thus filled up, is of course a perfect vacuum; and at a temperature below that now mentioned, the new fluid contracts, and the vacuity reappears, frequently with a rapid effervescence. These phenomena take place instantaneously, in several hundred cavities, seen at the same time.

The new fluid is also remarkable for its extreme volubility; adhering very slightly to the sides of the cavities; and is likewise distinguished by its optical properties. It exists, however, in quantities too small to be susceptible of chemical analysis. This new fluid is almost always accompanied with *another fluid* like water, with which it refuses to mix, and which does not perceptibly expand at the above-mentioned temperature.

In a specimen of *Cymophane* or *Chrysoberyl*, Dr Brewster has discovered a stratum of these cavities, in which he has reckoned, in the space of ¼th of an inch square, *thirty thousand cavities*, each containing this new fluid; a portion of the fluid like water, and a vacuity besides. All these vacuities simultaneously disappear at a temperature of 83°.

If such a fluid could be obtained in quantities, its utility in the construction of thermometers and levels would be incalculable. There are many cavities in crystals, such as those opened by Sir Humphry Davy, which contain only water, and which, of course, never exhibit any of the properties above described. An account of these results was read before the Royal Society of Edinburgh, on the 3d and on the 17th March.

22. *Pyro-citric Acid.*—This new acid, discovered by M. J. Lassaigne, is produced by the distillation of citric acid. It is white, inodorous, and of a strongly acid taste, and generally oc-

curs in a white mass, composed of fine small needles. It melts on a hot body, and is converted into very pungent white vapours, leaving traces of carbon. It is very soluble in water, and in alcohol. At 50° of Fahrenheit, water dissolves *one-third* of the weight of it. It is composed of

Carbon,	47.5
Oxygen,	43.5
Hydrogen,	9.

With the oxides it forms salts, which differ in their properties from the citrates. M. Lassaigne has examined the pyro-citrates of potash, lime, barytes, and lead.—*Journal de Pharmacie, October* 1822.

23. *Combination of Alcohol with Oil of Turpentine.*—M. Vauquelin has found, that if 100 parts, in volume, of volatile oil of turpentine, and 20 parts of alcohol, are mixed together, they are not separable by rest, but form a homogeneous body, an effect which arises from a solution of the alcohol in the oil. This compound does not become turbid by water.—*Ann. de Chim.* vol. xix. p. 279.

24. *New Compound of Iodine, Hydrogen, and Carbon.*—M. Serullas discovered this compound by dissolving to saturation iodine in alcohol of at least 39°. It consists of small pearly scales, of a sulphur-yellow colour. It is friable and soft; it diffuses, when rubbed, an aromatic odour. It is decomposed at a slight elevation of temperature. Water dissolves a very little of it, while it is very soluble in alcohol.—*Ann. de Chim.* vol. xx. p. 245.

25. *Hydro-carbo-sulphuric Acid.*—Dr Zeise of Copenhagen has discovered a new acid, which has the same relation to sulphuret of carbon, that hydrocyanic acid has to cyanogen. Its compounds have been called *Hydro-carbo-sulphates.* This new acid may be procured by pouring a mixture of four parts of sulphuric acid, and three of water, on the salt of potash, and adding much water in a few seconds. The acid collects at the bottom, in a transparent slightly coloured oil, which must be freed from sulphuric acid by washing. Its taste is acid and astringent. It reddens litmus paper. It burns readily, giving out sulphureous fumes. Its odour differs from that of sulphuret of car-

bon, and it is decomposed by heat.—*Ann. of Phil., New Series*, v. iv. p. 241.

MINERALOGY AND GEOLOGY.

26. *Cleaveland's Mineralogy and Geology.*—We have just received the second edition of this excellent work. It abounds in new and valuable information; and is equally distinguished with the former edition, for the accuracy of its descriptions, the fullness of its details, and the judiciousness of its views.

27. *Necker de Saussure's Travels in Scotland.*—This amusing and instructive book of travels, along with the "Essai Geologique sur l'Ecosse" of Boué, noticed by us in an early number of this Journal, ought to be in the hands of every foreigner who wishes to travel with advantage in our country. M. de Saussure's work contains not only numerous interesting and important details and reasonings, in regard to the geognosy of Scotland, but also much accurate information concerning the habits and manners of the people; the various useful establishments, particularly those which are characteristic of the country; and the whole is enlivened with historical details, and general popular observations and remarks.

28. *Formation of Calcareous Spar.*—Mr Haig, on pouring out the contents of a bottle of Saratoga water, which had stood several years in a cellar, found the bottom to contain well-defined crystals of calcareous spar, which, on being split, exhibited the usual cleavage of that substance.

29. *Neptunian Formation of Chalcedony.*—On opening a drusy cavity in Carrara marble, whose walls were lined with rock crystals, it was found to contain a pound and a half of a perfectly transparent and slightly sapid liquid. In the same cavity, a transparent mass, like rock-crystal, was observed, but which was so soft that it received the impression of the finger. On exposure, it became harder, and at length assumed the character of Chalcedony.

30. *Toad in a solid Rock.*—The workmen engaged in blasting rock from the bed of the Evie Canal, at Lockport, in Niagara County, lately discovered, in a small cavity in the rock, a toad in the torpid state, which, on exposure to the air, instantly revived, but died in a few minutes afterwards. The cavity was only large enough to contain the body, without allowing room

for motion. No communication existed with the atmosphere. The nearest approach to the surface was six inches through solid stone. It is not mentioned whether the rock was sandstone or limestone; but, from the prevalence of limestone on the surface of the contiguous country, it may be presumed to be the latter. The country is wholly of secondary formation. These animals have been frequently found imbedded in clay, gravel, &c. but no fact of their having been observed in rock is recollected *. Of the causes which enable animals of this class, which have been suddenly enveloped in strata of earth, or otherwise shut out from the air, without injury to the animal organs, to resume, for a limited period, the functions of life, on being restored to the atmosphere, no explanation need here be given, as the occurrence is a very common one, and is perhaps always more or less the result of galvanic action.—*Silliman's Journal.*

31. *Green Oxide of Zinc.*—Dr Torrey of New-York, has discovered and analysed a very valuable ore of zinc, which he names Green Oxide of Zinc. It contains oxide of zinc, 93.50; oxide of iron, 3.80; carbon, 1.00; = 98.00. The red oxide of zinc discovered by Dr Bruce, resembles this mineral in composition. It, however, differs from it, in containing 12 per cent. of lime, and in the absence of iron. It is by far the richest ore of zinc known. The red zinc-ore of Jersey, besides the manganese which it contains, is almost always mixed with more than half its weight of Franklinite, from which it is impossible to separate it by mechanical means; while the green oxide of zinc is so pure that it can be used without any preparation, either for extracting the metal, or for the manufacture of brass.—*Silliman.*

32. *Discovery of Datolite in America.*—The country near Patterson, in New Jersey, in America, is composed of red sandstone, with superimposed beds of secondary trap. The trap contains drusy cavities, in some of which are contained prehnite, mesotype, chabasite, stilbite and agate; in others, fine crystals of *datolite*, or siliceous borate of lime.

33. *Secondary Granite.*—M. Marzari observed in the vicinity of Recaro, in Italy, the following arrangement, proceeding from

* There are a good many instances reported by authors, of toads having been found in solid rocks.—Ed.

below, upwards, 1. Mica-slate; 2. Dolerite; 3. Red sandstone, with coal and bituminous marles; 4. Alpine or magnesian limestone; 5. Porphyritic syenite. In the Valley of Lavis (Aviso) he observed the following succession of rocks from below, upwards, 1. Grey-wacke; 2. Porphyry; 3. Red sandstone; 4. Alpine limestone; 5. Jura limestone; 6. Granite and augitic masses, without olivine. And Breislac, in a memoir lately published, says, that the secondary granite placed upon alpine limestone, is the same as the beautiful granite of Egypt, and contains great masses of quartz, with imbedded tourmaline.

34. *Rhinoceros' Horn found in Scotland.*—The horn of a rhinoceros found in shell-marl at the bottom of the Loch of Forfar, has been shewn to the Wernerian Society, and deposited in the Royal Museum of the University of Edinburgh. See p. 387.

35. *Turquoise of Persia.*—In the Bazar, at Bushehr, and at every large town in Persia, a multiplicity of small turquoises, and sometimes garnets, rubies, and other coloured stones, might be purchased, set in silver as rings; the Mahommedans, at least the men, not wearing such ornaments set in gold. The turquoise is an universal favourite, called *firuzeh*, or more properly *firuzel*, by the Persians, who believe that to look on it, when first awake in the morning, ensures prosperity, and highly strengthens and preserves the sight during the whole day. To look on the emerald also, is considered by the Persians as good for the eyes. It appears from Theophrastus, that the ancient Greeks entertained this opinion; Ἡ δὲ Σμάραγδος—καὶ πρὸς τὰ ὄμματα ἀγαθή. In the Classical Journal, No. I. p. 65, March 1810, some observations on the emerald may be found, which I derived chiefly from the *Tuáher Námah*, a Persian manuscript in my own collection, and below more fully quoted. These observations, from motives of secrecy which no longer exist, I communicated under a borrowed character, and the signature of Philosmaragdos. The efficacy of the turquoise, however, in this respect, does not altogether depend on magnitude; and, to the lower classes, a firuzel, not so large as a grain of wheat, (but seldom perfect), is sold with the silver setting for about one shilling. Such rings are daily seen on the coarse fingers of the muleteers, grooms, and

tent-pitchers; but when large, of a fine uniform colour, and free from blemish, their price is considerable, and I found at Cazvin that it was no longer possible to purchase for half a crown, like Olearius when there in 1637, turquoises equal in bigness to pease or beans.

This ingenious traveller, and after him Chardin, Tavernier and others, mention *Nishapúr* and *Firuzkúh*, as yielding turquoises most abundantly; but I could not learn whilst at Firuzkúh in 1812, that it was then remarkable for such a production. The Firuzehs of Nishapúr were more excellent than any others, as all accounts agree in stating. A manuscript treatire on precious stones, entitled the *Juáher Námah*, enumerates three places besides, which furnish mines of turquoises. Hamdallah Cazoini says, that the Firuzeh, when he lived, (between four and five hundred years ago), was chiefly worn by women, and considered (as it is now) inferior in value to the zumrad or emerald. Sehem ad' dúi, an author of the eleventh century, tells us that, "Piruzeh," (for so he writes it according to the original Persian Orthography), "being a stone without brilliancy, was not reckoned fit for the decoration of kings; but, on account of the name, (which signifies Victories or Fortunate), it was regarded as auspicious and lucky." Eastern mineralogists always rank the turquoise among stones; late experiments have cast some doubt on the propriety of such a classification.—Sir William Gore Ouseley's *Travels*, vol. i. p. 210 *.

BOTANY.

36. *Dr Hooker's Flora Exotica.*—Part 2d of Dr Hooker's *Flora Exotica* made its appearance on the 1st of December last, and we shall lay before our readers a brief account of its contents.

The first plate (t. 18) represents the truly beautiful and singular *Begonia argyrostigma*, a plant of very recent introduction to our gardens, and which, we believe, for the first time, in any collection, flowered in the stove of the new Edinburgh Botanical Garden. Its leaves are large, oblong, oblique, and in

* The turquoise of Persia is a true stone, not a fossil organic remain.—Ed.

shape, as well as many others of the same genus, bearing a resemblance to the ear of an elephant; beneath they are of an uniform red colour, and above of a fine deep green, with numerous spots, white and shining like silver; which gave rise to the specific name that first appeared in the *Hortus Gorenkensis* of Dr Fischer. These curious spots, though they have been supposed by some to be inconstant, are found to be quite otherwise, as seedling plants possess them even in a more striking degree than old ones. The *silver-spotted Begonia* is a native of the Brazils; and, from the facility with which it is increased, bids fair to be soon one of the most common, as it is one of the most beautiful inhabitants of our stoves.

T. 19. *Orontium aquaticum*, a hardy North American plant, of which no previous figure existed, that we knew of, save the miserable one in the *Amœnitates Academicæ*.

T. 20. a new and very singular species of *Cactus*, *C. truncatus*, which blossomed, for the first time in this country, at the Royal Botanic Garden of Glasgow, and shortly after at the garden of Liverpool. It is, like the rest of that family, leafless; the stems jointed; the joints singularly compressed, and truncated at the extremity; the flowers are large, handsome, and of a deep rose colour.

T. 21, 22, and 23, represent three species of *Peperomia*, viz. *blanda*, *quadrifolia* and *polystachya*. The genus was long confounded with *Piper*, but was separated by Humboldt and Kunth, because differing in the number of stamens, in the configuration of the stigma, and in the habit of the plants. There are some interesting general remarks upon the two genera, extracted from that learned but costly work of Humboldt's, the *Nova Genera et Species Plantarum*, and given under *Peperomia blanda*.

T. 24. *Velleia lyrata* of Mr Brown's Prodromus, a very pretty plant, with yellow blossoms, and belonging to the *Natural Order* GOODENOVIÆ of Brown.

At t. 25. we have a second species of *Doodia*, *D. caudata* (*D. aspera* being figured at t. 8. of Part 1.), a delicate fern, inhabitant of Port Jackson and Van Dieman's Land, but not yet cultivated in our gardens.

T. 26. *Caladium bicolor*, a handsome and well-known inhabitant of our hot-houses, remarkable for the rose-coloured tint

of the central part of its leaf, of which the margin is yellow-green; and figured, it appears, principally with a view to illustrate the character of the genus, by the dissections of the flower.

T. 27. *Caprifolium pubescens*, a charming, new, yellow-flowered, and sweet-scented *Honeysuckle*, recently discovered in the interior of Canada, by Mr Goldie, and at present only to be seen in the garden of Mr Smith, nurseryman, of Monkswood Grove, Ayr; who, however, is increasing it by cuttings, that it may be extensively distributed.

T. 28. *Anemia humilis:* one of the smallest of the fern tribe, of the division OSMUNDACEÆ of Mr Brown, and not much unlike the great *Flowering-Fern* (Osmunda regalis) in miniature.

T. 29. and 30. represent two species of *Hydrocotyle*, *H. nitidula* and *H. nepalensis*. The latter is remarkable for a strong carrot-like taste in the leaf, a circumstance, we are told, which it has in common with a nearly allied species from Tristan d' Acunha, the *H. capitata* of our countryman Captain Carmichael, in his very interesting memoir on the natural history of that island, published in the 12th volume of the Linnean Transactions.

T. 31. a new *Osbeckia* from Nepal, *O. nepalensis*, with very large and handsome flowers, and quite unlike any previously described species.

T. 32. *Stylidium laricifolium*, with ample analysis of its highly curious parts of fructification, which have been nowhere else satisfactorily represented, but in Mr Bauer's Illustrations of Mr Brown's *Prodromus of the Flora of New Holland.*

T. 33. Another elegant fern, and of easy cultivation in the stove, *Hemionitis palmata.*

In no respect, either in the execution of the plates, or in the interest of the subjects, is this second part of the *Exotic Flora* inferior to the first, of which we gave so favourable an account in our Number for October; and it is gratifying to us, as Scotsmen, to be able to announce the appearance of a publication which has so many claims to the attention of the scientific botanist.

37. *Mr Greville's Scottish Cryptogamic Flora.*—Eight numbers of this useful and original work have already appeared; and we are happy to find, from the estimation in which it is held by the public, that its regular continuance is secured.

Among the forty plants published, we find no less than twenty-three genera. Of *Fungi*; Sclerotium, Agaricus, Isaria, Æcidium, Peziza, Sphæria, Uredo, Fusarium, Cryptosphæria, Polyporus Puccinia, Amanita, Næmaspora, Erineum, Hysterium, Cylindrosporium, Aspergillus, Cyathus, Helvella, Clavaria, and Lycogola. Of *Algæ*; Echinella and Gloionema. *Cryptosphæria* and *Cylindrosporium* are new genera instituted by Mr Greville; the former to include a group of plants belonging to the old genus *Sphæria*; and the latter to receive a very curious, new and minute plant, that is parasitic on the living leaves of the common cabbage. The characters are,—*Cryptosphæria*; Receptacucum 0, sphærulæ duriusculæ, sparsæ vel aggregatæ, sub epidermide insidentes, ore nunc depresso nunc elongato, intus massa gelatinosa sporulifera instructæ. *Cylindrosporium*; Massæ minutissimæ in foliis vivis parasiticæ, non rupta epidermide. Sporidia cylindrica, truncata, non septata, nuda, libera, coacervata.

Besides these new genera, there are the following new species. *Isaria microscopica*; a minute species parasitic on Trichia clavata. *Æcidium Thalictri*; found on the Highland mountains, growing on Thalictrum alpinum. *Peziza ochracea*. *P. plumbea*. *Agaricus turgidus*; named from its remarkably hollow and turgid stem. *Amanita nivalis*; a beautiful species, found on the summits of the highest Grampians. *Næmaspora Rosarum*. *Hysterium Juniperi*; parasitic on the dead leaves of the common juniper. *Puccinia Fabæ*; found intermixed with *Uredo Fabæ*, on the leaves of the common field bean. *Gloionema apiculata*, and *Echinella circularis*, two interesting and curious plants of the order Algæ. *Aspergillus penicellatus*. *Sphæria verrucosa*; belonging to the division *Astomæ*, and parasitic on the pileus of Polyporus abietinus. The last new species is *Lycogola minuta*.

The colouring of the plates, on which so much depends in a work of this nature, does credit to the well known abilities of Mr Graves

ZOOLOGY.

38. *Notice regarding Skulls found in Germany, and Description of the Head of a Mummy.*—There has been discovered, in the neighbourhood of Halberstadt, in Saxony, a great

quantity of human skulls, which present marked differences with the European race, and which approach nearer the Coptic form. It is supposed that they have belonged to inhabitants of the primitive or antediluvian world. The most remarkable feature of these skulls is, that they have no incisors, and present only grinding teeth, from which it is conjectured that they have belonged to a frugivorous race.

Observations of M. Blainville.—We have given this scientific news, such as it has been related in the public prints, with the view of drawing the attention of anatomists toward those skulls of great antiquity, and which occur pretty frequently. We are, however, very far from being assured that those of which we speak were truly fossil, since nothing is said of the place in which they were gathered. With regard to the absence of incisors, and even of canine teeth, as, according to the accounts received, there were only molares, if the fact be certain, it is more than probable that it was merely accidental. We think it more rational to suppose that this case is analogous to the peculiar disposition of the canine teeth, which seem to be wanting in the skulls of the Egyptian mummies, but which have only been worn down, as well as the incisors, as has been observed by M. Sommering, and as I also have had an opportunity of seeing, in the beautiful heads of mummies brought home last year by M. Tedenat, son of the French vice-consul at Cairo. As these mummies have been freed, with singular felicity, not only of their envelopes, but also of all preservatory matter, and as all the parts of the face were in an excellent state of preservation, I shall here present the short description which I took of them.

The skin of these mummy heads is as it were tanned; the hair is well preserved; it is short and curled; it did not, however, appear woolly. The skin, and all the parts of the face, are perfectly preserved, that is to say, the eyes, the ears, the lips, and even the tongue; but the whole is black, or of a very deep brown.

The head or skull seemed to me in general smaller than in the European race, and especially the forehead, which is really narrow; the temporal fossæ rather shallow; the eyes large; or rather, the margin of the eye-lids much extended; the orbit, in fact, appeared to be greater in its lateral than in its vertical ex-

tent. The profile is not, however, that of the negro, although it has something of that race, especially in the lower part of the face. The nose, without being precisely flat, is still somewhat *en cornet*. The mouth is large, and very wide; the lips have not, perhaps, been thick, but the mouth is considerably protruded, on account of the inclination of the teeth, which are advanced, the lower meeting the upper. The incisors are much worn, and cut square, which is also the case with the canine; the chin, however, does not retire. The ears seemed in general placed pretty high, and to have the lobule small.

39. *Silk Worm.*—In a communication to the Society for Arts and Manufactures, (vol. iv. p. 163.), it is stated by Miss Henrietta Rhodes, that one line of the silk-worm, when unwound, measured 404 yards, and, when dry, weighed 3 grains. Hence it follows, that one pound avoirdupois of the thread, as spun by the worm, may be extended into a line 535 miles long, and that a thread which would encompass the earth would weigh no more than 47 pounds.

40. *Supposed Written Characters on the Wing of the Locust.*—So many travellers, naturalists, and, it may be said, antiquaries, have contributed to illustrate the subject of locusts, that I can add but little to the result of their researches. It must however be here remarked, that Zakaria Cazvini divides the locusts into two classes like horsemen and footmen, "mounted and pedestrians," which will call to the recollection of the biblical reader, some passages from Joel and the Apocalypse.

That certain extraordinary words were supposed to be inscribed on the wings of locusts, different authors have related. The Sieur de Beauplan heard from persons well skilled in various languages, that the characters were Chaldaic, and formed *Bozc Guion*, words signifying the "Scourge of God." But a much longer legend is exhibited on the wings of locusts, and in the Arabic language, if we may believe those mussulman writers, to whom I have referred in a former work. "We are the army of the Mighty God; we have each ninety and nine eggs; and had we but the hundredth, we should consume the world, and all that it contains." Whatever characters they may resemble, the marks appearing on locusts' wings are presented to the read-

er's inspection in a very accurate delineation, which I made at Bushehr, from one of those creatures, just before it was consigned, with hundreds more, to the Arab cook; and many of their real wings, perfectly preserved between the leaves of a book, are still in my collection.—*Note.* M. de Paw in his Récherches Philosophiques sur les Egyptiens et les Chinois, vol. i. p. 131, (Berl. 1773), alludes to a passage of Varro, mentioning that the Roman flamens abstained from eating beans, because their flowers contained infernal letters, and adds, "ces lettres infernales sont les deux taches noires." So the Chinese have discovered mystical letters in the lines on a tortoise's back; but Mr Barrow, (China, p. 278), has completely dispelled the fancied mystery; it is, says he, but the common school-boy trick of the magic square, or placing the nine digits, so that they shall make the sum of fifteen every way,

$$\text{Thus: } \begin{cases} 2\ 9\ 4 \\ 7\ 5\ 3 \\ 6\ 1\ 8 \end{cases}$$

Gore Ouseley's *Travels.*

41. *Economy of the Toad* (*Rana Bufo*).—"The common food of the toad is small worms, and insects of every description; but its favourite food consists of *Apis mellifica*, *A. conica*, *A. terrestris*, and *Vespa vulgaris.* When a toad strikes any of these insects, however, deglutition does not immediately take place, as in other cases, but the mandibles remain closely compressed for a few seconds, in which time the bee or wasp is killed, and all danger of being stung avoided. The mandibles are provided with two protuberances, which appear to be destined for this office. Although capable of sustaining long abstinence, the toad is a voracious feeder, when opportunity offers. To a middle-sized one, the writer has given nine wasps, one immediately after another; the tenth it refused, but in the afternoon of the same day it took eight more. To see the toad display its full energy of character, it is necessary to discover it in its place of retirement for the day, and, if possible, unperceived, to drop an insect within its sight: it immediately arouses from its apparent torpor, its beautiful eyes sparkle, it moves with alacrity to its prey, and assumes a degree of animation incompatible with its general sluggish appearance. When arrived at a proper distance, it makes a full stop, and, in

the attitude of a pointer, motionless eyes its destined victim for a few seconds, when it darts out its tongue upon it, and lodges it in its throat with a velocity which the eye can scarcely follow. It sometimes happens to make an ineffectual stroke, and stuns the insect without gorging it, but never makes a second stroke until the insect resumes motion. It uniformly refuses to feed on dead insects, however recent. For several years a toad took up its abode, during the summer season, under an inverted garden-pot, which had a part of its rim broken out, in the writer's garden, making its first appearance in the latter end of May, and retreating about the middle of September. This toad, there is reason to believe, distinguished the persons of the family, who daily fed it, from strangers, as it would permit them to pat and stroke it. To try the indiscriminating appetite of these animals, the writer has dropped before a full-grown toad, a young one of its own species, about three-fourths of an inch long, and the instant it began to move off, it was eagerly struck at and swallowed; but the writer, in repeating this experiment, found that more will refuse than devour the young of their own species. When living minows (*Cyprinus Phoxinus*) were dropped before a toad, they were struck at and swallowed in the same manner. These experiments were made on toads at full liberty, and met with accidentally. Toads generally return to their winter quarters about the time that swallows disappear. The writer, on such occasions, has seen them burrowing in the ground backwards, by the alternate motion of their hind legs."—*Letter from Mr Fothergill to Dr Sims, F.L.S.*

42. *Spur of the Ornithorhynchus.*—" You will be gratified to learn, that I have been completely successful in establishing our friend Sir John Jamison's account of the spur of the *Ornithorhynchus paradoxus.* I subjoin an extract from my notes:—' *Sunday, Oct.* 1. 1820.—On the banks of Campbell's River. In the morning shot a male *Ornithorhynchus.* On examination, soon after it was killed, I observed near the extremity of the convex side of the spur, a minute spot, like the orifice of a tube; and, on endeavouring to pass a bristle from this spot, three successive drops of a limpid clear fluid issued from it. I then examined the other spur with the same result. On dissecting the foot of the animal, I found, at the inner side of the root of

the spur, immediately over the articulation, a small cyst, which I cut into; it did not, at that time, contain any fluid; but from it I, with great ease, passed a horse-hair through the spur. This preparation I have sent to you, together with the dried cyst.'

"You will also be pleased to learn, that I have been fortunate enough to get an impregnated female of this interesting animal. I give you another extract from my notes: '*Bathurst, Oct.* 13.—After breakfast went with Mr Scott to examine a hole, where we had been told that a wounded *Ornithorhynchus* had taken refuge, and which we hoped might prove to be the animal's nest; but, on digging, we found it to be that of a rat. On returning, however, we were gratified in finding that a female *Ornithorhynchus* had been brought in alive, having been found on its nest, in a lagoon near Campbell's River, by Mr Rawley, who says that he was obliged to tear the nest to pieces, before he could get the animal out, the nest being formed of reeds and rushes, with a long tube or entrance into it, out of which the bill of the animal only was visible. The animal was placed in a bucket of water, in which it seemed to enjoy itself for some time, occasionally getting on its back in the water, to scratch its head with the hind foot. The eyes are small and prominent, of a muddy-brown colour, with blue pupil, and are situated immediately behind the skinny flap at the base of the bill. After a short time, it did not seem to like being in the water, and therefore it was taken out; a string was tied round the leg, and it was allowed to go on the grass, where it crawled along, seemingly with difficulty. It appeared to like having its head scratched, as it allowed me to do so without moving.' '*Oct.* 14....Found the *Ornithorhynchus* nearly dead, and proceeded to examine its structure. The *rectum*, *vagina*, and urinary bladder, have one common orifice. On opening the abdomen, I was much gratified to find, in the left ovarium, a round yellow *ovum*, about the size of a small pea. There were also two of smaller size, and an immense number of minute vesicles, hardly perceptible to the eye, but distinctly visible under the microscope. There was no uterus, nor any viscus similar to it, but only a tube leading up from the cloaca, which divided into two ducts leading to the ovaries, similar in situation

to the Fallopian tubes of viviparous animals, but much larger and wider. There was not any appearance of impregnation in the right ovarium.' I cut out the whole of the internal parts of generation, the urinary bladder, part of the rectum, and also the whole of the cloaca unexamined, and put them into spirits. This preparation is now in the possession of Mr Scott, who is to take it with him to England, and who will, I am sure, feel much pleasure in shewing it to you *. In this preparation the urinary bladder must not be mistaken for an uterus.

"Cookoogong, a native, chief of the Boorah-Boorah tribe, says, that it is a fact well known to them, that this animal lays two eggs, about the size, shape, and colour of those of a hen; that the female sits a considerable time on her eggs, in a nest, which is always found among the reeds on the surface of the water; that the animal can run on the grass, and is sometimes found at a considerable distance from the water; that he is also perfectly aware, that a wound from the spur of the male is followed by swelling and great pain; but although he has seen many cases of it, he has never known it fatal; that the flesh of the animal is never eaten, and that the native name is *Mullingong*."—*Letter from Mr Hill, surgeon, Sydney, to the Secretary of the Linnean Society.*

43. *Hybernation of the Corncrake* (Rallus Crex).—Major Morrison, an intelligent observer, communicated to us the following interesting note.

"As it still appears a matter of doubt, whether the Corncrake should be included among those birds that occasionally fall into a torpid state during the winter, I beg to offer the following circumstance towards settling this point. A gentleman of the town of Monaghan, in Ireland, some years since, had, on or near his farm, a large heap of manure that had remained undisturbed for a considerable length of time. The labourers, in removing this manure in winter, and during a frost, perceived a hole in the side of the heap, which had probably been made by rats; and, after a great portion of the manure had been taken away, they came to the end of the hole, where they found three corn-

* Mr Scott, upon his arrival in England, presented the preparation to the University of Oxford.

crakes, as if they had been placed there with the greatest care, not a feather being out of its place, and apparently lifeless. The circumstance surprised the workmen so much, that they took the birds to the farmer, who, having examined them, was of opinion they were in a torpid state; and being desirous of ascertaining whether it was the case, placed them near a fire in a warm room. In the course of a very short time, he observed a tremulous motion in a leg of one of the birds. He soon after noticed motion in the legs and wings of the whole. Efforts to move and rise became rapidly more apparent; and, finally, the birds were enabled to run and fly about the room. These particulars were related to me by the farmer in the year 1806."

A similar fact is mentioned in Mr Neill's Tour in the Orkney and Shetland Islands, p. 204., on the authority of a gentleman of the country.

IV. GENERAL SCIENCE.

44. *Colour of the Arabian Sea.*—Soon after two o'clock of February 12. 1811, a partial line of *green* water, such as generally indicates shallows, and perfectly different from the *blue* of a deep sea, was perceived extending considerably. It appeared at first to be two or three miles before us, and was probably eight or nine from land. The navigating master did not suppose that it was occasioned by a shoal, but ascribed it rather to the late fall of rain. Some thought it the effect of tides, or feared that we had approached a sand bank; and the pilot acknowledged that many parts of this coast were but little known, as vessels inclined mostly to the opposite Arabian shore. Our ship, therefore, was put about. We then sounded, and were relieved from any apprehension by finding the depth to be sixty-three fathoms. Towards evening we sailed directly into the line of green water; and so strongly and suddenly was it distinguished from the blue surface which we had left, that, as a passenger remarked, the Lion must have been at one moment floating in a sea of two different colours. Here we again sounded, but could not find bottom at less than seventy-nine fathoms. Had this phenomenon been peculiar to the Persian Gulph, not far from the entrance to which we observed it, the epithet *green*, bestowed on that branch of the ocean by eastern geographers,

would seem more applicable than many terms used in the description of other seas.—Gore Ouseley's *Travels*, vol. i., p. 152.

45. *Schmidt on the Height of the Atmosphere.*—Schmidt, in his "Ideen über die ursach der begränzung unsers Luft Kreisses et über die bestimmung der höhe derselben in Gilbert's Annalen 1819," conceives that the limit of our atmosphere is at that boundary, where the specific elasticity of the air is balanced by the power of gravitation. Calculation gives as the result, that, in those places where the mean temperature of the earth's surface is 22° 4′ R., the height of our atmosphere is equal to 7.22 German miles. On the contrary, where it is 0°, the height is 6.6 German miles. Beyond these limits, according to this conception, no air will occur.

46. *Account of a Cavern* * *of Lava.*—The following interesting account of this cavern is taken from Dr Webster's description of St Michael's:

"Having reached a field between three and four miles NW. from the city, we discovered the entrance to the cavern. It is a fissure in the rocks, which here rise only a few feet from the surface, and is about wide enough to admit two persons abreast. The bottom, when viewed from the entrance, for some yards formed a gently inclined plane; but as we proceeded, the rocks spread out on both sides, and we soon found ourselves in a spacious apartment, the floor of which was heaped with huge fragments of lava, that had fallen from above, and over which our progress was for some distance difficult, and rather dangerous. At the distance of ten or twelve yards from the entrance, we came suddenly upon the edge of a precipice, beyond which it seemed impossible to proceed. Creeping, however, with caution along the edge, we presently came to a point where an accumulation of fragments afforded a natural but dangerous passage, and, by leaping from rock to rock, we at last reached the bottom.

"The height of the precipice was probably not less than thirty feet; and as the torches with which we were provided served to illuminate the cavern but feebly, we directed our guide to kindle a fire. From the sound of our voices, we were of opi-

* The application of the expressive term *cavernous* to the lava, has been adopted, as Professor Silliman observes, from Sir George Mackenzie's work on Iceland.

nion that this apartment was of great extent, and the strongest light we could obtain did not enable us to discern the roof. The light of the fire, strongly contrasted with, and gradually lost in the surrounding darkness, produced a very picturesque effect, which was greatly heightened by the situation of our party, some of whom were obscurely seen standing upon the huge fragments of rocks, while others were passing and repassing in various directions, exploring a passage to the recesses of the cavern. Having groped about for some time, over and among rocks of all sizes and shapes, which were piled on each other in every possible manner, we at length discovered on our right a chasm about two feet in width. Looking into it from above, the space below appeared to enlarge, and the lava on which we stood to form the roof of another cavern beneath us.

The floor was covered with fragments of every size, and from the roof hung stalactites of lava; an appearance highly interesting, and which amply repaid me for the danger and difficulty encountered. On breaking the stalactites, they were found to be much more porous and vesicular than any lava I had previously seen. The cells were nearly perfect spheres, arranged in concentric circles, and most of them were large enough to contain a pea. They were not visible, however, till the stalactites were broken, being covered with a smooth and hard crust. The partitions between the cells were less than the sixteenth of an inch in thickness, and had an imperfect glimmering lustre on the fresh fracture. Most of them contained a loose brown earthy matter, probably the result of partial decomposition. The stalactites externally, have a dark iron grey colour, sometimes passing to black; and they are deeply enamelled in a longitudinal direction. They occur of all sizes; some of them are less than an inch in length, while others exceed a foot. Their diameter is not less variable, but never exceeds six inches at the thickest part. Those which were about a foot in length were usually from one to three inches thick.

The difficulty of penetrating to the last apartment of the cavern was by no means inconsiderable; and for the last few yards we were obliged to creep upon the bottom, and advance with the utmost caution; while the sharp points of hundreds of stalactites were in contact with one another. Some of the circumstances

noticed in the lava of these caverns are curious, throwing light on the manner in which they may have been formed, the lava appearing like melted lead thrown into water; the walls, in some places, seem to be covered with petrifactions or vegetables, and shrubs retaining the most perfect resemblance to their originals; some specimens resembled bunches of grapes partially flattened, and some were like coarse salt." *Webster's Account of the Island of St Michael's.*

47. *Lithographic Prizes to be adjudged by the Society of Arts for Scotland.*—The gentlemen who, in 1820, associated themselves for the purpose of promoting the art of Lithography in Scotland, have transmitted the balance of their funds to the Society for promoting the useful arts in Scotland, for the purpose of forming three Prizes for improved specimens of printing, to be produced from lithographic designs. The particulars and conditions of the prizes will, we understand, be published soon, along with several other premiums to be offered by the Society of Arts.

48. *Wire Gauge recommended by the Society of Arts.*—The Society of Arts, considering the inconvenience arising from the present uncertain construction of wire-gauges, are about to recommend, for the adoption of artists, a new form of gauge, which will shew the diameter of wire in decimals of an inch. A description of this instrument will appear in our next Number.

49. *Dr Charles Anderson's Machine for measuring small quantities of Fluids.*—" The want of the proper means (Dr Anderson remarks) of ascertaining, with precision and expedition, small quantities of fluids in chemical experiments and pharmaceutical operations, has often been the subject of complaint. The glass measures recommended by the Colleges of Physicians of London and Edinburgh, and now in general use, are well fitted for measuring ounces and drachms, but they do not seem calculated for measuring smaller quantities with sufficient accuracy.

" The mode of ascertaining small quantities of fluids by drops, has been so long in use, that custom seems to have established an undue predilection in its favour. It must, on very little reflection, be obvious, that this mode is very uncertain. As the size of the drops must vary much, depending on the viscidity of the fluid; the thickness of the lip of the bottle from which they fall;

and the celerity with which they follow each other; and as many of the most active medicines now in use, and prescribed in this way, are virulent poisons, much uncertainty, and even danger may arise from it.

"The late Dr Black, with a view to obviate the inconvenience arising from this vague and indefinite manner of ascertaining small doses of tinct. of opium, &c. proposed that the lips of the phials kept in the apothecaries shop for this purpose should be ground to a certain thickness. More lately, the College of Physicians in London, has sanctioned the use of a slender tube, graduated in a particular manner, known by the name of Lane's Drop Measure. At first sight, this tube may be supposed to answer the purpose; but, in charitable institutions and extensive pharmaceutical practice, its use appears to me to be attended with many inconveniences: as, when employed, it is to be immersed to the requisite depth into the fluid designed to be measured, it is plain that the fluid must be first poured from the bottle in which it is kept, into some convenient vessel fit for the immersion of the tube. Besides, in so slender a tube, and consequently of very considerable length, it is obvious that a good deal of the fluid will adhere to its external surface, which must fall along with the contents into the phial which it is to be transferred to, giving rise to much uncertainty and inconvenience. This can only be avoided by wiping the tube after every immersion, which produces great delay. With the view of obviating these late inconveniences, I have constructed the measure represented in Fig. 17. of Plate VII. It resembles the conical glass measure of the London College; but, in place of being closed, the lower part is drawn out to a slender tube, fitted for being graduated, and the end of this is provided with a stop-cock DE, to prevent the exit of the fluid to be measured, until the quantity required be accurately ascertained. This measure is graduated from 2 ounces down to 5 grains; and, by a little more nicety in the blowing, it might be carried still lower. The stop-cock has a hole in it, *m n*, which permits the fluid to escape, when it is turned, as in the figure. By means of this apparatus, a small quantity of any fluid may be correctly measured and transferred to a phial, or any other vessel, with no greater loss than arises in passing through an ordinary funnel."

ART. XXIII.—*List of Patents granted in Scotland from 14th November 1822 to 6th March 1823.*

27. TO WILLIAM LISTER of Baildon, parish of Otley, county of York, cotton-spinner, for an invention "of certain improvements in the method and machinery for preparing and spinning wool, silk, mohair, or other animal fibre, of any quality or length of staple." Sealed at Edinburgh 27th November 1822.

1. To HENRY HOULDSWORTH of Glasgow, civil engineer, for an invention of "a new and improved method or contrivance for heating dwelling-houses, hot-houses, and other buildings and erections." Sealed at Edinburgh 8th January 1823.

2. To JAMES PERKINS, late of Philadelphia, United States of America, now of Fleet Street, London, engineer, for an invention "of certain improvements on steam-engines." Sealed at Edinburgh 8th February 1823.

3. To WILLIAM BRUNTON of Birmingham, county of Warwick, engineer, for an invention "of certain improvements upon fire-grates, and the means of introducing coal therein." Sealed at Edinburgh 8th February 1823.

4. To JAMES FOX of Plymouth, county of Devon, rectifier, for an invention "of an addition or additions to, or an improvement or improvements on the apparatus commonly used in the distillation of ardent spirits." Sealed at Edinburgh 3d March 1823.

5. To PHILIP CHELL of Earl's Court, Kensington, county of Middlesex, engineer, for an invention "of certain improvements on machinery for drawing, roving, and spinning hemp flax and waste silk." Sealed at Edinburgh 6th March 1823.

6. To RICHARD BADNALL the younger, of Locke, county of Stafford, silk-weaver, for an invention "of certain improvements in the throwing, twisting, or spinning of sewing silks, Organzine Bergam, and such other descriptions of silk as the said improvements may be applicable to." Sealed at Edinburgh 6th March 1823.

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LIST OF PLATES IN VOLUME VIII

P. Neill Printer